CCAFS outcomes evaluation report – Volume 3
Outcomes 2010 – 2016 influenced by CCAFS’ climate products

Edited by Kornelia Rassmann
May 2017

Preamble
This is Volume 3 complementing four further volumes of an evaluation report commissioned by the CGIAR Research Program on ‘Climate Change Agriculture Food Security’ (CCAFS). The evaluation was undertaken by the independent evaluators Kornelia Rassmann and Tonya Schuetz and supported by the CCAFS internal evaluation team led by Philip Thornton and Laura Cramer. It mainly used Outcome Harvesting (OH) but also elements from Impact Pathway thinking and Contribution Analysis to describe and analyze ‘development outcomes’ that were directly or indirectly influenced by one of three CCAFS’ climate products – the GCM Climate Portal, MarkSimGCM, and the Climate Analogues tool.

OH is a very participatory evaluation approach where the informants develop narratives together with the evaluators on how a particular societal actor changed through a specific intervention (here involving one of CCAFS’ climate products), and what has led to the change. The resulting narratives are collected in this volume.
Use of the report

The evaluation report comprises five volumes for different anticipated audiences.
Volumes 1 to 4 are available from the CGIAR website (http://hdl.handle.net/10568/81536)

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CCAFS governance and management, funders, partners, stakeholders | **Main evaluation results** – Executive summary; background to the evaluation, its design and methodology (Sections 1, 2, 3); an overview on the cases that were researched in more depth (Section 4); answers to the evaluation questions based on the outcomes data (Section 5); insights from the evaluation process (Section 6); and recommended discussion points and opportunities (Section 7). |
| **Volume 2**  
CCAFS governance and management, funders | **Survey results and user perspectives** – Findings and conclusions from an online survey to the users of CCAFS climate data/tools, i.e. the potential contributors to development outcomes, conducted during the outcome harvest. |
| **Volume 3**  
CCAFS governance and management, funders, partners, stakeholders | **Outcome stories** – The narratives developed together with our informants during this evaluation, describing who has been influenced to change in what way, and what contributed to these changes. |
| **Volume 4**  
CCAFS management team | **Terms and coding book** – Definitions and classifications developed jointly by the internal and external evaluation teams to get a common understanding of terms; effectively organize and interpret the data; and potentially inform future CCAFS monitoring and evaluation. |
| **Volume 5**  
Internal (not published) | **Databases, presentations, compiled secondary sources** – Excel databases developed during this study; PowerPoint presentations to guide discussions with the CCAFS evaluation team; interview data; researched literature. |
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Acknowledgements

The consultants, Kornelia Rassmann and Tonya Schuetz, and the CCAFS evaluation management team are deeply grateful to the informants of the outcome narratives compiled in this volume. The following authors engaged enthusiastically in this evaluation and were prepared to commit substantial amounts of time to the interviews and the collaborative drafting of SMART outcome stories:

Benjamin Ford, Research Assistant, University of Western Australia; Danni Guo, Senior Scientist, South African National Biodiversity Institute, South Africa; Deissy Martinez Baron, Science Officer, CIAT/CCAFS, Colombia; Juan Cruz Colazo, Soil Scientist, San Luis Research Station, INTA, Argentina; Liliana Paz, Executive Director, Fundación Ecohabinat, Colombia; Luis Ortégarc Fernandez, Director Areas Protegidas, Fundación Ecohabinat, Colombia; Michael Jennings, Research Professor, University of Idaho, USA; Paul Wagstaff, formerly Agriculture Advisor at Concern Worldwide; Prabhat Ojasvi, Principal Scientist, Indian Institute of Soil and Water Conservation, ICAR, India; Rocío Ponce-Reyes Postdoctoral Research Fellow at CSIRO, University of Queensland, Australia; Samuel Bacon, Australian agricultural aid worker, Seeds for Life, Timor Leste.

We also greatly appreciate the invaluable input and time invested by regional CCAFS contacts supporting two detailed ‘Climate Analogues’ case studies:

The ‘Farms of the Future Africa’ contribution was coordinated by Osana Bonilla-Findji, CCAFS/CIAT, Colombia, who engaged with the CCAFS East Africa team including Phillip Kimeli, Mary Nayasimi, Maren Radeny, Catherine Mungai and John Recha from the International Livestock Research Institute, ILRI (a CGIAR Center); as well as the West Africa team with Mathieu Ouedraogo, ILRI, and Abdoulaye S. Moussa, CIAT.

The ‘Seeds for Needs India’ informants were from the CGIAR Center Bioversity International and included Prem Mathur, formerly Regional Representative for Central and South Asia, now Honorary Research Fellow; Sarika Mittra, formerly Scientific Officer; Arnab Gupta, Scientist for Agroecology and Seed Systems, Neeraj Sharma, Scientist, Crop Diversification and Seed Systems, and Sonal Dsouza, Communication and Programme Assistant.

Gathering the specific details needed to formulate SMART outcomes takes several rounds of interviews and iterative editing and amending the draft narratives. This time intensive process has resulted in the rich data compiled in this volume. Together with additional information obtained from further contacts they build the essential basis for our findings and conclusions summarised in Volumes 1 and 2.
Acronyms

ACIAR  Australian Centre for International Agriculture Research
ANACIM  Agence nationale de l'aviation civile et de la météorologie, Sénégal
ASA  Action for Social Advancement, India
Ashok  Ashok Sansthan, India
BHU  Banaras Hindu University, Varanasi, Uttar Pradesh, India
BRACED  'Building Resilience and Adaptation to Climate Extremes and Disasters' (DFID)
CATIE  Centro Agronómico Tropical de Investigación y Enseñanza
CC  Climate Change
CCAFS  CGIAR Research Program on Climate Change, Agriculture and Food Security
CENRM  Centre of Excellence in Natural Resource Management
CGIAR  formerly the Consultative Group for International Agricultural Research
CIAT  International Center for Tropical Agriculture, Cali, Colombia, CGIAR Center
CIMMYT  International Maize and Wheat Improvement Center, CGIAR Center
CPT  Climate Predictability Tool
CRP  CGIAR Research Center
CS  Crowdsourcing trials
CSA  Climate smart agriculture
CSIR-SARI  Savanna Agricultural Research Institute, one of the 13 Research Institutes under the Council for Scientific and Industrial Research
CSIR-ARI  Animal Research Institute (Council for Scientific and Industrial Research)
CSO  Civil Society Organisation
CSV  Climate Smart Village
DFID  Department for International Development
DGVS  Dirección General de Vida Silvestre, Mexico
DRI  Deendayal Research Institute, India
DWR  Directorate of Wheat Research, ICAR, India
EQ  Evaluation question
ETJ  Estudio Técnico Justificativo
FotF  Farms of the Future
GBIF  Global Biodiversity Information Facility
GCM  General Circulation Model
GIS  Geographic Information Systems
HCT  the Humanitarian Coordination Team, UN
HPPI  Humana People to People, India
IARI  Indian Agricultural Research Institute
ICAR  Indian Institute of Soil and Water Conservation
ICRAF  World Agroforestry Centre, CGIAR Center
ICRISAT  International Crops Research Institute for the Semi-Arid Tropics, CGIAR Center
IDO  Intermediary Development Outcome
IER  Institut d’Economie Rurale, Mali
IFAD  International Fund for Agricultural Development
ILRI  International Livestock Research Institute, CGIAR Center
INERA  Institut de l'Environnement et Recherches Agricoles, Burkina Faso
INGO  International non-governmental organisation
INRAN  Institut National de la Recherche Agronomique du Niger
INTA  Instituto Nacional de Tecnología Agropecuaria
IP  Impact Pathway
IPCC-AR5  5th Assessment Report of the International Panel of Climate Change
IPG  International Public Goods
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>IP-OH</td>
<td>Impact-Pathway related Outcome Harvesting, using also elements from Contribution Analysis, a methodology developed for this evaluation</td>
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<tr>
<td>IRI</td>
<td>International Research Institute for Climate and Society</td>
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<td>ISRA</td>
<td>Institut Sénégalais de Recherches Agricoles</td>
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<tr>
<td>KALRO</td>
<td>Kenya Agricultural &amp; Livestock Research Organization</td>
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<td>KVK</td>
<td>Krishi Vigyan Kendra</td>
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<tr>
<td>MAF</td>
<td>Ministry of Agriculture and Fisheries, Timor-Leste</td>
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<td>MEL</td>
<td>Monitoring, evaluation and learning</td>
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<td>NACC</td>
<td>Northern Agricultural Catchments Council, Australia</td>
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<td>NARCO</td>
<td>Nepal Agricultural Research Council</td>
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<td>NARES</td>
<td>National Agricultural Research and Extension Services</td>
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<td>NBA</td>
<td>National Biodiversity Assessment, South Africa</td>
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<td>NBG</td>
<td>National Bureau of Plant Genetic Resources, India</td>
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<td>NBPG</td>
<td>National Bureau of Plant Genetic Resources, ICAR, India</td>
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<tr>
<td>NEFORD</td>
<td>The Nand Educational Foundation for Rural Development, India</td>
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<tr>
<td>NGO</td>
<td>Non-governmental organisation</td>
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<td>NRI</td>
<td>Natural Resources Institute of the University of Greenwich, UK</td>
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<td>ODK</td>
<td>Open Data Kit</td>
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<td>OECD-DAC</td>
<td>Development Assistance Committee’ of the ‘Organisation for Economic Cooperation and Development’</td>
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<td>OH</td>
<td>Outcome Harvesting</td>
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<td>OM</td>
<td>Outcome Mapping</td>
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<td>PAU</td>
<td>Punjab Agricultural University, Ludhiana, Punjab, India</td>
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<td>PGR</td>
<td>Plant genetic resources</td>
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<td>PMKSY</td>
<td>The Indian national program ‘Pradhan Mantri Krishi Sinchayee Yojana’</td>
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<td>PVS</td>
<td>Participatory Varietal Selection trials</td>
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<tr>
<td>R&amp;D</td>
<td>Research and development</td>
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<td>R4D</td>
<td>Research for Development</td>
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<td>S4N</td>
<td>Seeds for Needs</td>
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<td>SANBI</td>
<td>South African National Biodiversity Institute</td>
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<td>SEMARNAT</td>
<td>Natural Resources Secretary, the Mexican Minister for the Environment</td>
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<td>SLO</td>
<td>System Level Outcomes</td>
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<tr>
<td>SMART outcomes</td>
<td>Outcomes described in a specific, measurable, achieved, relevant, and timely way</td>
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<td>SoL</td>
<td>Seeds of Life, Timor-Leste</td>
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<td>SRES</td>
<td>Special Report on Emissions Scenarios</td>
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<td>SRF Phase II</td>
<td>CGIAR Strategy and Results Framework (2016-2030)</td>
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<td>Sub-IDO</td>
<td>Sub Intermediate Development Outcome</td>
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<td>SWCC</td>
<td>South West Catchments Council, Australia</td>
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<td>ToC</td>
<td>Theory of Change</td>
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<td>UK</td>
<td>United Kingdom</td>
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<td>UN</td>
<td>United Nations</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework on Conventions Climate Change</td>
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<td>USA</td>
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1. Introduction

The effects of climate change (CC) – global warming, climate variability and extreme weathers – present a major challenge to humanity. They threaten particularly the poorest people, living in vulnerable areas with few resources, where an increase in temperature and an increase in frequency of droughts and floods can cause dramatic crop and livestock production losses.

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) integrates CC work across all 15 CGIAR Centers and the CGIAR Research Programs. Up to date CCAFS has been successfully producing a wealth of data, tools, models and approaches for innovative CC research, among these three online tools offering researchers data for climate projections, namely

i) **GCM Climate Portal**, an online platform providing access to high resolution statistically downscaled future climate surfaces which was published by CIAT/CCAFS in 2008 (Ramirez & Jarvis, 2008; [tool website](#)).

ii) **MarkSimGCM**, a stochastic weather generating tool published in 2013 by Waen Associates and CCAFS (Jones & Thornton, 2013; [tool website](#)), which has a visual interface based on Google Earth satellite imagery and maps.

iii) **Climate Analogues tool**, using one or more global climate models to project future (or current) climate and rainfall predictions for a particular site and locate where else in the world one could find a comparable current (or future) climate.

In 2016, CCAFS commissioned an evaluation of the development effectiveness of CCAFS’ climate data/tools; this document is Volume 3 of the resulting report and contains the outcomes data, i.e. the evidence collected and assessed during the study. More specifically, the purpose of the evaluation was to assess i) whether the use of the three climate products above has influenced stakeholders to do things differently in relation to decisions in, e.g., research agendas, capacity development, investment, programming, and policy formation; if so, ii) what changes in knowledge, attitude, relationships, policy or practice were observed, and iii) how and to what extent CCAFS outputs or activities involving the three products contributed to such outcomes. The results shed light on the question whether CCAFS’ climate products offer an added value provision supporting a successful implementation of its Phase II 2017-2020 program.

The main evaluation approach used in this study was Outcome Harvesting (OH), a utilization-focused, highly participatory method that enabled the external evaluators to work very closely with the internal evaluation management team and the informants. It is a very powerful approach that can unpack outcomes at various stages of the impact pathway – from the more basic immediate results to those further downstream and potentially more transformative – and thus helps to unfold and/or test a program’s Theory of Change. The outcome harvest in this study was guided by the standard OH SMART criteria (Box 1b) for the evaluation period 2010-2016 (CCAFS’ Phase I).

Over 100 outcome leads were collected through various methods including document reviews, interviews and an online survey to tools users (see Volume 2 of the evaluation report). About 30 cases were researched in more detail and 14 of these could be turned into SMART outcomes for which a clear linkage to one of the tools could be established. These data are presented here and constitute evidence that outcomes linked to CCAFS’ climate data/tools – as defined in this evaluation – did emerge during the evaluation period.

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**Box 1a: CCAFS’ climate products**

- **GCM Climate Portal** housing global datasets of climate change projections for climate change impact assessment, downscaled from several methodologies;
- **MarkSimGCM** simulating daily weather data specifically designed for use in the tropics, including rainfall, maximum and minimum temperatures and solar radiation;
- **Climate Analogues**, allowing researchers to identify, connect and map sites with statistically similar climates across space and time.
There were eight outcomes for the GCM Climate Portal and six for the Analogues tool, yet none for MarkSimGCM (see Volume 1 for a discussion of this). The changes covered immediate, intermediate and ‘ultimate’ / ‘impact-near’ development results and came from a broad geographic range covering four continents. They involved various societal actors including funders investing in further climate research; NGOs or government agencies adapting their programming, national governments changing their planning for climate change adaptation; and communities and farmers engaging in programs employing CCAFS’ climate tools and taking up climate smart agricultural practices.

The research activities and outputs contributing to the 14 outcomes fell into three categories:

- the GCM Climate Portal was used in CC impact studies (4 outcomes, Section 2.1), and
- for species/habitat distribution modeling (4 outcomes, Section 2.2), and
- the Climate Analogues tool served to identify climate analogue sites for varying purposes (6 outcomes, 4 of these reported in Section 2.3).

Two of the 14 SMART outcomes were researched in more depth:

- the ‘Farms of the Future’ (FotF) case was described as an extended outcome story (Section 3); and
- the ‘Seeds for Needs India’ (S4N) case was assessed through an adaptation of OH employing elements from Impact Pathways thinking (Douthwaite et al., 2008) and Contribution Analysis (Mayne, 2008) (Section 4).

The Impact-Pathway OH approach (Figure 2) was developed particularly for this evaluation and resulted in 18 SMART outcomes for the S4N program. These were clustered by similar type of societal actor and change in order to formulate ‘umbrella outcomes’, which were then arranged in an ‘Outcome Map’ roughly reflecting the causal pathway of results observed. This ‘Outcome Map’ was used when engaging with informants to harvest more evidence along the impact pathway focussing particularly on assessing the contribution of the climate tool (i.e. the informants were asked to specify exactly which outcomes were influenced by the use and outputs of the tool and, where this was the case, to rate its importance). In this way, the approach helped to untangle the contribution of one of CCAFS’ climate products – the Climate Analogues tool – to a specific, large-scale national program.

Figure 1: OH steps and adaptation for Impact-Pathway Outcome Harvesting.

Steps 2 to 4 of the standard OH methodology were adapted to allow harvesting of outcomes along a retrospectively constructed impact pathway. The steps are repeated iteratively engaging in several rounds of reviewing the outcomes data and the ‘Outcome Map’ together with the informants, ensuring that the key societal actors and changes are captured and that the causal assumptions are plausible.
2. SMART outcome narratives

2.1. GCM Climate Portal: species/habitat modeling

2.1.1. Michael Jennings, University of Idaho: US Fish and Wildlife Service co-funds a study on climate change influences on ecosystem vegetation in southern USA that employs GCM Climate Portal (B22)

Outcome description
In 2016, the US Fish and Wildlife Service co-funded a second, more detailed study on climate change influences on ecosystem vegetation in southern USA, led by Dr Grant Harris and involving a range of cooperating / collaborating / multi-funding partners. This research started on 01.11.2016 and will apply the methods developed previously to evaluate how specific habitat types across an area of about 1,228,167 km of the southwestern USA—especially those habitats of sensitive and endangered species occurring on wildlife refuges and elsewhere—are likely to change in plant species composition over the decades between now and the 2030s, 2050s, and 2070s.

Contribution description
Between 28.06.2010 and 28.07.2015, GCM Climate Portal data were used by Drs Michael Jennings, University of Idaho, and Grant Harris, US Fish and Wildlife Service Southwestern Region, in a study to develop and test methods with which to identify the specific climate-vegetation parameters needed for anticipating how, where, and when the composition of ecosystem vegetation transforms with climate change. The methods developed in this pilot study quantify the relationships between climate change and ecosystem composition. Results from this work were first published in the journal 'Landscape Ecology' (Online First version) in April 2016 and then in the January 2017 issue (32(1):195–207; open source: http://link.springer.com/article/10.1007/s10980-016-0435-1). This paper has already been downloaded almost 800 times and read widely within the US Fish and Wildlife Service, including the Director Dan Ashe and his staff.

Significance of outcome
Projecting the loss of suitable climate for the vegetation composition of ecosystems is important for assessing threats from climate change and for setting priorities for ecosystem conservation and restoration. Although it may be difficult to anticipate exactly how policy will be developed and implemented in the future, Dr Jennings expects that results of this study will be used to develop fairly high resolution predictive understandings of how the plant species composition—thus structure, disturbance, and dynamics—of particular ecosystems and habitat types will most likely change over the decades of this century. The methods developed by this effort can be applied to any terrestrial region of Earth. They can be used quantitatively to inform decisions of land acquisition and management treatments.

Importance of contribution
For the pilot study the authors used bioclimate variables provided by CCAFS of a single climate model downscaled to 1 km. Dr Jennings discovered the CCAFS climate data/tool through a web search and has been using it since c. 2006/7 without any further training. He values particularly that the GCM Climate Portal data are readily available; downscaled to a resolution useful for studying biotic responses to climate; that the downscaling procedures are transparent; and that CCAFS provides access to individual climate models (as opposed to only ensembles), which is vitally important as described in some detail the discussion section of their paper.
2.1.2. Benjamin Ford, University of Western Australia: National Resource Management groups start incorporating climate change effects into their planning (S01)

Outcome statement

The South West Catchments Council (SWCC) co-funds work and publishes reports incorporating climate change information from the GCM Climate Portal into their national resource management projections. For example, at least three of SWCC’s climate change related reports (prepared by the consultant Simon Neville, Ecotones & Associates, in 2014) use research results provided by the Center of Excellence in Natural Resource Management (CENRM) from their work on developing a framework for assessing the vulnerability of aquatic species to multiple threats in South Western Australia, employing information retrieved through the GCM Climate Portal. The work was funded by the Department of the Environment (through the Australian Government’s Regional Natural Resource Management Planning for Climate Change Fund), and the South West Catchments Council (SWCC) (additional funding for the application to the Blackwood River catchment).

Similarly, the Northern Agricultural Catchments Council (NACC, http://www.nacc.com.au/) have incorporated projections of bioclimatic envelop shift between 2000 and 2080 from CENRM at the University of Western Australia in their report 'NACC Corridors for Climate Change MCAS-S Framework', published in March 2015 (also prepared by Simon Neville, Ecotones & Associates). The report summarises the work, conclusions and recommendations from the modelling and mapping to support biodiversity prioritisation and climate planning for the Northern Agricultural Region covered by NACC.

Contribution statement

Barbara Cook, Acting Director, and Benjamin Ford, Research Assistant/PhD student at the University of Western Australia, developed and applied a framework for assessing the vulnerability of 101 aquatic species (93 invertebrates and eight fish species) to multiple threats in South Western Australia, employing data retrieved through GCM Climate Portal. The system used in the study was the Blackwood River which is under SWCC jurisdiction. Several workshops and meetings were held with SWCC and other NRMs over the duration of the project. A report on the Blackwood study was published in 2015 and the results will be submitted for publication in a peer-review journal in early 2017.

Significance of outcome

NRM groups periodically release ‘strategies’ and the framework for assessing the vulnerability of aquatic species developed by CENRM will likely be incorporated into SWCC’s next strategy. Uptake of spatial prioritisation into planning by the SWCC was significant for both current activities and to account for climate change projections. Co-operation and collaboration among SWCC and other NRM groups was also greatly increased. The NRM groups of South Western Australia are just initiating the incorporation of climate change into their planning. Some groups are more pro-active than others (i.e. considering future climate suitability of tree species being planted for carbon sequestration), but the collaboration between SWCC and CENRM has enhanced their use of our results. Providing the groups with the ability to include climate change into planning will almost certainly improve their conservation efforts.

Importance of contribution

Ben Ford states that, at the time of the research, the required GCM and SRES combinations were not available from other sources (i.e. WorldClim), so GCM Climate Portal was essential for collecting climate data used in the species distribution modelling. One of the SWCC reports (http://bit.ly/2jkLnW5) acknowledges that "Ben Ford (CENRM) [...] developed a range of new data structures that are much more useful to NRM groups. He has provided background information used in the text [...] and has been really good at providing data."
2.1.3. Danni Guo, South African National Biodiversity Institute: The next South African National Biodiversity Assessment is likely to include biome change predictions assessed through CCAFS climate data (S04)

Outcome description
In October 2016, Fahiema Daniels, Deputy Director, Biodiversity Planning & Policy Advice, at the South African National Biodiversity Institute (SANBI) and Danni Guo, Senior Scientist: Spatial Data Modeller Statistical Ecology Unit (SANBI) verbally agreed to include findings from predictions on biome changes influenced by climate change into the next South African National Biodiversity Assessment (NBA). Fahiema Daniels is in charge of the terrestrial section at SANBI and Danni Guo is doing climate change modelling. Employing the GCM Climate Portal, Danni conducted research on the conservation of Quiver trees (Aloe dichotoma, Conophytum) in Namibia and South Africa under a changing climate. The Quiver tree is essential to the local ecosystem and environment, because it is a source of moisture for a wide variety of mammals, birds and insects. The NBA participation is definite, and Danni Guo received email invitation to join the NBA GIS group.

Contribution description
In May 2016, Danni Guo from SANBI and colleagues published research on the conservation of Quiver trees in Namibia and South Africa under a changing climate employing data from the GCM Climate Portal and WorldClim (http://www.scrip.org/journal/68805.html). The research is still ongoing as part of the NBA; the deadline for research for the NBA is in 2018. Andrew Skowno from SANBI is the NBA science lead; Danni Guo is not directly involved in the NBA, but has been to meetings.

Significance of outcome
The South African National Biodiversity Assessment (NBA, https://www.sanbi.org/nba) is a product of high scientific importance led by the South African National Biodiversity Institute (SANBI) in collaboration with the Department of Environmental Affairs and several other partner organisations (e.g. Department of Fisheries, CSIR, Stellenbosch University, University of Cape Town, Nelson Mandela Metropolitan University...). The NBA provides headline indicators for monitoring & reporting and summarises spatial biodiversity priorities based on best available science. It informs the SA National Biodiversity Strategy & Action Plan required by the UN Convention on Biological Diversity. Thus, used in the NBA reports, the data for climate impact analysis (specifically for Conophytums) will contribute toward policy making and increase general awareness into biodiversity.

Importance of contribution
The study used data from CCAFS Climate Portal and from WorldClim. Danni Guo appreciated the easy to use Ascii format and good resolution of the CCAFS data, as well as the support he received from the CCAFS technical support. Danni Guo is currently the only person at SANBI doing climate modelling; he formerly worked at the SANBI climate change unit, which however was dismantled 3 years ago; now the work involves biodiversity research and reporting. Previously, climate change has played a role in the NBA work, and Danni Guo is aware of an NBA report with a climate modelling component, but it was unclear which model was used.

2.1.4. Rocío Ponce Reyes, University of Queensland, Australia: A Mexican NGO engages with climate researchers to produce advocacy material on threatened cloud forests after reading their research informed by CCAFS’ Climate portal (S08)

Outcome statement
‘Pronatura Veracruz’, a Mexican NGO involved in ecoforestry) became more aware of the vulnerability of cloud forest reserves in Mexico to climate change and engaged in producing advocacy material
targeted at the Mexican government after reading publications by Rocío Ponce Reyes and colleagues the School of Biological Sciences, University of Queensland. In 2013, staff from the NGO (Fadi Najib Farhat) contacted Rocío Ponce Reyes to 1) participate in a webinar which was part of their online course on cloud forest ecological restoration (run every year by Pronatura) explaining the potential vulnerability of Mexican cloud forests climate change; and 2) collaborate with them to produce a document to convince the Mexican government to declare some forest patches in the outskirts of Xalapa City, Veracruz Mexico, as critical habitat. The development of the document started in June 2013 and it was finished in 2014; it is published on the Pronatura website.

Contribution statement
In 2011, Rocío Ponce Reyes from the School of Biological Sciences, University of Queensland, Australia, conducted research employing the GCM Climate Portal to show that 68% of Mexico’s cloud forest could vanish by 2080 because of climate change and more than 90% of cloud forest that is protected at present will not be climatically suitable for that ecosystem in 2080. Moreover, if it is assumed that unprotected forests are cleared, 99% of the entire ecosystem could be lost through a combination of climate change and habitat loss, resulting in the extinction of about 70% of endemic cloud forest vertebrate species. The work was published in ‘Nature Climate Change’ in March 2012. Rocío Ponce Reyes sent a copy of the paper to colleagues in Mexican Universities and Governmental offices involved in biodiversity conservation (such as CONABIO and CONANP). Even before the paper was published, Rocío Ponce Reyes presented the results at the Society of Conservation Biology in Auckland. After the publication there was a press release from the University of Queensland and one co-author, Dr Reynoso, was interviewed in Mexico for Gaceta UNAM. In 2013, a second scientific paper was published in ‘Diversity and Distributions’ in 2013. Further, Rocío Ponce Reyes further wrote a couple of pieces for the general audience: “Head in the clouds: reserves won’t save Mexico’s forest”, published in ‘The Conversation’, 7th September 2012, and “Staying alive in a shrinking cloud forest-The story of the bird, the frog and the mouse”, published in ‘Decision Point’ #72. August 2013. Pronatura Veracruz were aware of the Nature Climate Change and contacted the researcher after the publication in Decision Point, asking her to include some of the material of the 2013 paper in a webinar.

Significance of outcome
The objective of the work with Pronatura was to declare the study area as a ‘Critical Habitat’ in order to obtain funds from the federal government to protect and restore the habitat. The analyses indicated that one key area for immediate protection was the Sierra de Minas in Veracruz, Mexico. This area supports many endemic species and is expected to retain relatively large fragments of cloud forest despite rapid climate change. The document produced with Pronatura was sent to the Wildlife General Direction (Dirección General de Vida Silvestre; DGVS) from the federal Natural Resources Secretary (the Mexican Minister for the Environment, SEMARNAT) and the Attorney General’s Office (Secretaria de Governacion). It was expected that these would lobby and promote the document in order to be approved and implemented. The document was received by the DGVS and they suggested to change the format to a ‘Supporting Technical Study’ (Estudio Técnico Justificativo; ETJ). And there was a casual agreement to pass the document to the Secretaries mentioned above. The document is still with the SEMARNAT (but the process has been stopped since the change of directors in the Secretary and there is no specific date to re-start). However, Pronatura Veracruz, has still been working in the region, promoting the creation of Private Conservation Areas. The certification is ongoing so the final amount declared as a Private Conservation area is still unknown.

Importance of contribution
For their species / habitat modelling, Rocío Ponce Reyes and her colleagues retrieved climate data solely through the GCM Climate Portal. They state that they could not have done their analyses without these data. The publication and promotion of the results of this research raised the attention of Pronatura and directly lead to the NGO contacting the researchers.
2.2. GCM Climate Portal: climate change impact studies

2.2.1. Samuel Bacon, Seeds for Life, Timor-Leste: NGOs in Timor-Leste adapt in their planning to respond to climate risks predicted through climate modeling using the GCM Climate Portal (S05a)

Outcome statement
During the recent El Niño cycle in 2016, all major NGOs in the Timor-Leste, including e.g. CARE and World Vision, who were coordinated with the UN in the Humanitarian Coordination Team (HCT), reprioritized their activities and responded more timely to a climate event predicted through climate modeling using the GCM Climate Portal. After learning about the looming drought event in a meeting with Samuel Bacon from Seeds of Life (SoL) in mid-2015, the NGOs started planning for the drought instead of going forward with the original idea to develop a response plan to a major flood as a hypothetical exercise. Emergency response measures were implemented with hygiene packs, water filter systems, food and other assistance measures. In Timor-Leste, El Niño starts in May but impacts on the following wet season, allowing six months within which the NGOs were able to coordinate across the agencies the educational packages to warn farmers of the drought about to occur and how they could better prepare for it.

Contribution statement
Samuel Bacon and his colleagues from Seeds of Life, a program within the Timor Leste Ministry of Agriculture and Fisheries (MAF), conducted research on the impact of climate change on maize production in Timor-Leste from 2010 until 2016, employing data from the GCM Climate Portal and WorldClim. The research was published and the findings and implications promoted through workshops and educational sessions to government staff and numerous INGOs working in the field of climate change (see outcome S05a). In mid-2015, the INGOs invited Samuel Bacon to the HCT meeting organised by the United Nations in Timor-Leste to present information about climate and, in particular, the looming El Niño event. Graphical information in the form of maps showed current climate information sourced through the WorldClim portal as well as future climate modelling sourced through the GCM Climate Portal. This information supported SoL’s urgent call for the HCT to begin advance planning for the possible impacts of El Niño. Based on this information the NGOs’ adapted their programming to respond adequately to the forthcoming drought.

Significance of outcome
Advanced planning of responses to the El Niño crisis enabled the members of the HCT to act more coordinated and have clearly defined action plans that aligned with the planned response. This resulted in farmers being better prepared and NGOs improving their coordinated response to the unfolding disaster. The clear understanding of the situation supported the release of more funds from the Government and international bodies to assist the farmers.

Importance of contribution
When the recent strong El Niño came to Timor-Leste the Seeds of Life program had very good credentials as being the ‘go-to’ organisation for quality climate information, which was partly based on the research using the GCM Climate Portal. They were the key presenters to Government (Ministry of Agriculture and Fisheries, Ministry of Social Solidarity, Ministry of Public Works) as well as all major NGOs in the country who were coordinated with the UN in the HCT to respond to the unfolding difficulties. Samuel Bacon says that “…the modelled data was able to provide a balanced and scientific analysis of the real predicted changes in climate rather than the ‘hype’ that is so often presented. For example, at a national climate change conference to the government, NGOs and public, some very
notable presentations were saying a possible increase of 1 – 4m rise in sea level was implied to impact the capital city of Dili. The actual predicted rise over the next 50 years is about 20cm for our area. We were able to present the data from CCAFS in graphic format using maps to show changes in temperature and rainfall which were more meaningful and gave more validity to our presentation. In short, having this data gives us more confidence in knowing what the real predictions are rather than relying on journalistic hype”.

2.2.2. Samuel Bacon, Seeds for Life, Timor-Leste: Government of Timor-Leste co-funds climate risk adaptation measures after being informed by research employing CCAFS' climate data (S05b)

Outcome statement
Research on the influence of climate change on maize production in Timor-Leste led to increased understanding of climate related risks in national government bodies. During the El Niño cycle in 2016 that caused an extreme drought on the island, the Government of Timor-Leste (Ministry of Agriculture and Fisheries, Ministry of Social Solidarity, Ministry of Public Works) responded to the unfolding difficulties by committing around $12 million USD to buy reserve food stocks. The El Niño cycle is not directly related to climate change, however it is difficult for most people to differentiate the two and thus the severe weather conditions provided an opportunity to generally raise awareness and increase knowledge on climate factors. The educational work of the ‘Seeds of Life’ (SoL) program (an agricultural livelihoods program of the Australian Centre for International Agriculture Research, ACIAR, funded by the Australian government’s aid program in Timor-Leste), often includes information on weather, climate variation and climate change.

Contribution statement
Samuel Bacon and his colleagues from Seeds of Life, a program within the Timor Leste Ministry of Agriculture and Fisheries (MAF), funded collaboratively by MAF and the Australian Government, conducted research on the impact of climate change on maize production in Timor-Leste from 2010 until 2016, employing data from the GCM Climate Portal, as well as from WorldClim. The research was presented in two research papers (Molyneux, 2012, and Bacon, 2016) as well as climate information sheets covering the nation and in their annual research reports during that period which are available online (http://seedsoflifetimor.org/climatechange/climate-change-in-timor-leste/). Apart from publishing and presenting the research, Samuel Bacon and colleagues promoted their work through workshops and educational sessions to government staff in Agriculture as well as to numerous INGOs such as CARE and World Vision working in the field of climate change (especially on land conservation to reduce erosion during storm events). The data, along with a lot of other climate and land related data, was also supplied to a wide range of other stakeholders such as engineers for bridge building and road construction, drainage (especially for the low lying capital city of Dili).

Significance of outcome
Samuel Bacon thinks that "in the context of a developing country that is trying to rebuild from a traumatic struggle for independence, climate change does not have great immediate relevance. That is, these are people trying to get food on the plate this week so they are not too concerned about 50 or 100 years into the future. In that sense, from an objective point of view, there was not a lot of specific changes in policy to implement real change.” Still, he expects the research findings to influence "most major and minor NGOs and Government bodies as well as investors in Timor-Leste". In the outcome described here, the academically rigorous presentation of climate information stimulated INGOs on Timor-Leste to align their planned responses and the clear understanding of the situation supported the release of more funds from the Government and international bodies to support these activities and assist the farmers to be better prepared for the unfolding disaster.
The activities of the SoL program in Timor-Leste ceased end of 2016, but the research and data from the SoL program were handed over to the Australian funded follow-on project TOMAK. It is very different from SoL, but is the leading Australian agriculture project for Timor-Leste. TOMAK has asked SoL staff (including Samuel Bacon) to do some consultancy for the project to get up and running.

**Importance of contribution**

(See Outcome 1) The CCAFS information supported an academically rigorous presentation that influenced the Government and NGOs to respond more timely and adequately to a predicted climate event. The CCAFS information was part of the foundation of knowledge on climate. As Samuel Bacon states: “Like all good foundations, the majority of people don’t see it and forget that it’s there but without it our society is at the mercy of the latest twitter”.

2.2.3. Prabhat Ojasvi, Indian Institute of Soil and Water Conservation, ICAR: Indian Cabinet approves a water-energy nexus program that is partly informed by data from the GCM Climate Portal (S11)

**Outcome statement**

The Indian Cabinet Committee on Economic Affairs chaired by Hon’ble Prime Minister approved the national program ‘Pradhan Mantri Krishi Sinchayee Yojana’ (PMKSY) in its meeting held on 1st July, 2015 that was partly informed by research based on CCAFS’ climate data. PMKSY aims to extend the coverage of irrigation and improve water use efficiency through better end-to-end solution on source creation, i.e. improving the complete system from water source to its utilization at farmers’ fields including water distribution network, water management and conservation, field application and extension activities. Climate information accessed through the GCM Climate Portal contributed to assess the future water demand in agriculture (domestic, crops, animals and industrial) in two locations, one in Uttar Pradesh and one in Gujarat. The results were used to assess water demands that helped the Department of Agriculture to develop a long term demand-driven irrigation development plan for all districts in India, involving water conservation practices as part of this national program. PMKSY will be implemented across the country with an outlay of Rs. 50,000 crore in five years.

**Contribution statement**

Between 2010 and 2012, Prabhat Ojasvi, Principal Scientist (Hydrology and Watershed Management) at the Indian Institute of Soil and Water Conservation, Dehradun (an institute of the Indian Council of Agricultural Research - ICAR, New Delhi), together with research partners from the Indian Institute of Management, Ahemdabad, and Indian Institute of Technology, Delhi, conducted research on the impact of climate change on the Water-Energy Nexus in agriculture for canal irrigation systems. Data including the means, precipitation and temperature at the finest resolution were downloaded from the GCM Climate Portal to develop a conceptual framework for future water supply and demand, interlinking climate change with water and energy and agriculture in the context of two canal irrigation systems, the Sharda Sahayak Canal Command Area (~0.18 Mha, 18 districts of UP) and the Sardar Sarovar Canal Command area (Gujarat). The study was published in 2012.

**Significance of outcome**

The programme architecture of PMKSY will adopt a ‘decentralized state level planning and projectised execution’ structure that will allow the State Agriculture Departments (as further key game changers) to draw up their own irrigation development plans based on District Irrigation Plan (DIP) and State Irrigation Plan (SIP) (adapted from http://pmksy.gov.in/AboutPMKSY.aspx). In addition, PMKSY aims to converge the work of several departments like Irrigation, Groundwater, Horticulture, Rural development, Watershed and Agriculture which were hitherto working in isolation.
Importance of contribution

While climate data was also retrieved from www.worldclim.org, Prabhat Ojasvi confirmed that CCAFS provided a spectrum of future climate scenarios along with updates in an easy to use format for their study and thus helped to estimate future water demands for their study sites.

2.2.4. Juan Cruz Colazo, Soil Scientist, Research Department, INTA: The Argentinian Government publishes research informed by the GCM Climate Portal in a book on Argentinian agricultural production and climate change (S12)

Change statement

In 2014, the Ministry of Agriculture of Argentina (http://www.agroindustria.gob.ar) for the first time published a book on climate change with the title ‘Soils, agricultural production and climate change: advances in Argentina’. The book was composed of peer-reviewed papers that comprised the majority of respective studies conducted to this date by researchers from Argentinian public or private institutions. The editors of the book, Carla Pascale Medina, Ministerio de Agricultura, Ganadería y Pesca and Universidad de Buenos Aires; María de las Mercedes Zubillaga, Universidad de Buenos Aires, and Miguel Ángel Taboada, Instituto Nacional de Tecnología Agropecuaria (INTA) and Universidad de Buenos Aires, invited Juan Cruz Colazo, INTA, and colleagues to provide a chapter on “Climate change and wind erosion in Argentina”, which is included in part 3 of the book, titled ‘Changes in land use and soil degradation’. Juan Cruz Colazo used data from the GCM Climate Portal to analyse the effects of future climates as triggers for wind erosion. The ‘Asociación Argentina de la Ciencia del Suelo y la Asociación Argentina’ provided institutional, and the ‘Ministerio de Agricultura, Ganadería y Pesca de la Nación’ provided institutional and financial support to publish the book. The book was announced mainly in scientific meetings (e.g. the national soil congress) and it is available as pdf from the website of the University of Buenos Aires (http://ced.agro.uba.ar/ubatic/?q=node/79).

Contribution statement

Between 2010 and 2013, Juan Cruz Colazo, Soil Scientist at the Research Department, San Luis Research Station, INTA, conducted research combining a field-scale wind erosion model with future climate estimations in a GIS, in order to address the spatial and temporal (1950 – 2000, 2030, 2050) variation of wind erosion risk at a national scale. The research was financed by INTA, which is part of the ministry.

Significance of change

In the introduction the editors state that before publication of the book in 2014 there were few compilations of studies focusing specifically on the relationship between climate change and soils. They hope the material will be well received by all the community, including not only the academic and technical sectors, but also decision makers in the public and private sectors. So far, Juan Colazo and his team have been consulted by other research groups about the methodology and the data they used in the study. For example, in 2014 INTA initiated a soil national program, in which erosion modelling was an important part. Juan Colazo and his team have shared the information generated with the climate data with other research groups inside the program. Also some people from provincial governments have requested the maps. However, there Juan Colazo is not aware of any concrete planning or investment decisions influenced by the findings published in the book.

Importance of contribution

According to Juan Colazo, the data they retrieved through the GCM Climate Portal was very robust and essential for their work. Their paper (Chapter 29) is one of 46 chapters in the book.
2.3. Analogues tool: identification of climate analogue sites

2.3.1. Paul Wagstaff, Concern Worldwide: Farmers in Sierra Leone start growing cash crops from climate analogue sites in a pilot trial (PW1)

**Outcome description**

In 2016, 60 farmers from Tonkolili district, Sierra Leone (5 each from 12 villages), participated in a visit to a climate analogue site in Bo District identified using CCAFS’ Analogues tool to learn from the experiences of farmers in climate analogues sites and initiate information exchange. As a result of the visits the farmers from the villages in Tonkolili district saw an opportunity to invest in robusta coffee and cocoa, crops not previously grown in the district and started sourcing coffee and cocoa germplasms from Bo District, which are now in the village nurseries. They are planned to be brought to the fields in the near future. Also, so far Concern Worldwide had been procuring tree seedlings for reforestation and shading trees for the farmers’ tree nurseries from the Forest Department nursery in Freetown. The Climate Analogues analysis showed that the Western Peninsular, where Freetown is located, had a very low similarity to the climate expected in Tonkolili District in 30 years-time so procurement was switched to Bo District.

**Contribution description**

Concern Worldwide has been working in Sierra Leone since 1996 and currently works in, Tonkolili District and in Freetown/Western Area. About 4 to 5 yrs ago, Concern started to integrate climate change perspectives in their programming, initially in Sierra Leone. Concern's Climate Analogues work in Tonkolili District is part of the EU funded Kangari Hills Forest Conservation Project (https://www.concern.net/where-we-work/africa/sierra-leone), where, for example, tree nurseries are set up to facilitate reforestation. The Climate Analogues analysis was done in the second half of 2015 (after the Ebola crisis). In November 2015, Concern organised a training course lead by Paul Wagstaff for Concern field staff as well as representatives of the Sierra Leone Ministry of the Environment. Analyses using the Climate Analogues tool showed that the material used for the tree nurseries from the Freetown nursery was not likely to do well in 30 yrs; Bo District was identified as the climate analogue site and the farmers agreed to participate in a farmer-to-farmer visit. During this workshop, the participants also discovered that farmers from Bo District were successfully growing coffee and cocoa as cash crops.

**Significance of outcome**

Demonstrating that the sourcing of tree germplasm from the nursery in Freetown is not helpful will prevent wasting money and time on unnecessary measures. Moreover, starting to grow climate adapted cash crops will open up new financial opportunities. The project is currently on hold at Concern, waiting for further funding from Irish Aid.

**Importance of contribution**

According to Paul Wagstaff from Concern Worldwide, it took some time to get climate change and agriculture on the agenda for Concern’s focus countries; but since c. 4 or 5yrs they are using climate information, particularly the Climate Analogues tool - which has the most direct link to agriculture - for many of their countries in an explorative way. It started in Sierra Leone during collaborative work with the ‘Natural Resources Institute’ (NRI), Greenwich University, where they collected farmers’ perceptions of climate change. A researcher from NRI had worked on the development and piloting of the Climate Analogues tool in East Africa, though NRI admitted that they found it difficult to use in their own work in East Africa. However, for the Concern study in Sierra Leone, the results turned out to be very useful: Paul Wagstaff thinks that “the Climate Analogues concept is most relevant for long-term investments, like tree planting – which is exactly what the software showed us.” The tool
worked well for the Sierra Leone study because there were good analogues sites within the country, in similar soils and topography; there were clear differences in farming systems so that the recommended changes made sense. Also, the changes concerned tree crops, and the value is higher in such long-term investments since climate change also occurs also in longer term perspectives.

2.3.2. Paul Wagstaff, Concern Worldwide: DFID is funding a project lead by Concern Worldwide which is piloting an advanced version of the Climate Analogues tool for their climate related work in Chad and Sudan. (PW2)

Outcome description
In 2014, DFID has awarded a 3-yr grant to a consortium of Concern Worldwide, the CGIAR center ICRAF, Tufts University (USA) and the Sudanese NGO Al Massar under the ‘Building Resilience and Adaptation to Climate Extremes and Disasters’ (BRACED) programme for a research and learning phase on how to build community resilience amongst 280,000 people to the effects of regular droughts in West Darfur and Eastern Chad. Key components of the project included increasing access to basic services; climate smart agriculture and the development of early warning systems. During this learning phase, Concern Worldwide and the International Council for Research in Agroforestry (ICRAF) were testing the use of the CCAFS’ Climate Analogues tool to locate sites currently experiencing the climate that farmers may experience in 2050. Despite initial doubts concerning the approach, an initial report sent to DFID was seen positively by the DFID advisor. The final report of the pilot work lead by Rolandt Kindt from ICRAF will be submitted to DFID end of 2017 for the next funding round.

Contribution description
For their work in Chad and Sudan, Concern Worldwide together with ICRAF, Tufts University and Al Massar developed a proposal to DFID that had a strong action research component and could conclusively prove, or disprove, the Climate Analogues concept. The project itself is expected to provide clues to the strategies required for communities in the Sahel in order to adapt to climate change, particularly for long-term investments, such as tree plantations. The project is still in the development phase and Rolandt Kindt from ICRAF was engaged to test and adapt the CCAFS’ Climate Analogues tool for this work. For example, the analysis for project sites in Chad produced analogue sites that were either very close to project villages, on very different soil types, or in areas that were inaccessible for security reasons. Therefore, Roeland is currently adding soil types, vegetation data and crop responses to climate stress into his models. For Chad, analyses include 71 villages (88,000 people) in the Sila Region, using the output from 24 General Circulation Models (monthly precipitation, maximum temperature, minimum temperature, and bioclimatic variables) for two radiative forcing values (RCP 2.6 and 8.5), with climatic distance measured by both the CCAFS’ method and a normalising method (based on the Mahalanobis distance) to reduce the influence of extreme values. Information gathered from local field studies or databases is used and compared so as to provide data for further studies, propose high-potential adaptation pathways, facilitate farmer-to-farmer exchange of knowledge, validate computational models, and test new technologies and/or techniques.

Significance of outcome
According to Paul Wagstaff from Concern Worldwide, the results of the pilot study will be highly significant, potentially changing the way how DFID will work by motivating them to integrate climate modelling into their programming. The BRACED call is intended to create learning on Resilience and document best practice for future Resilience interventions.
**Importance of contribution**

According to Paul Wagstaff, the prospect of climate modelling had a role in attracting the initial funding from DFID. Though DFID had reservations about the Climate Analogues concept they were happy to keep an open mind as the concept was integral to the theory of change developed for the proposal and the Concern Worldwide/ICRAF/Tufts/Al Massar proposal had a strong action research component that could conclusively prove, or disprove, the Climate Analogues concept. Concern experienced some constraints when using the Climate Analogues tool as provided on CCAFS’ website for their Sahel study. The software looks at climate factors, but the researchers found that other parameters such as soil types, or African vegetation maps also needed to be linked in. Also, there were issues that the predictions obtained through climate change modelling did not always correspond with the notions of the locals, i.e. that rainfalls have decreased over time (though there may be a bias in personal perceptions and difficulties with interpreting climate variability and long term trends). The project is incorporating these learnings, building on CCAFS’ Climate Analogues tool and adapting it further for research in Concern projects, for public use and for training of students.

**Outcome description**

Since beginning of 2016, Concern Worldwide is developing its strategy for the next 4 years of work in Liberia; the contextual analysis now includes analyses based on CCAFS’ Climate Analogues tool. The analyses predict that analogues sites for Liberia are coffee / cocoa producing sites in Ivory Coast. Therefore, Concern’s proposal to Irish Aid and other donors now includes a focus on agro-forestry, aiming to build up the skills set of the Concern staff in Liberia accordingly (for formative research), as well as build capacity in Liberia institutions and establish linkages among relevant institutes. Networking in Liberia will start next year, exploring potential collaborations.

**Contribution description**

The positive experience with the Climate Analogues tool in Sierra Leone (see PW1) has convinced Paul Wagstaff, Agriculture Advisor at Concern Worldwide, to promote its use for other projects of Concern.

**Significance of outcome**

Concern is also recommending the use of the Analogue tool to its stakeholders and funders: for example, IFAD funds cocoa and coffee projects in Liberia (Paul Wagstaff talked to a nursery manager). Furthermore, Concern has also provided advice on using Climate Analogues analyses to NGOs working in other countries, most recently WeltHungerHilfe in Zimbabwe. Apart from this, Paul Wagstaff is visiting lecturer at Irish universities lecturing on the Climate Analogues tool for 3 years (i.e., in total 60 students at Masters level and 30 students at undergraduate level).

**Importance of contribution**

The Climate Analogues tool has a direct link to agriculture and is used as a learning resource in many focal countries of Concern Worldwide in an explorative way. Paul Wagstaff states that the online version is easy to use and the instructions are good.
2.3.4. Luis Alfonso Ortega-Fernandez, Fundación Ecohabitats & Deissy Martínez Barón

CCAFS: Fundación Ecohabitat integrates climate predictions modeled with CCAFS’ Climate Analogues tool into local adaptation planning in Colombia (B42)

Outcome description

During 2016, Fundación Ecohabitats has collaborated with CIAT incorporating for the first time climate predictions derived through the CCAFS Climate Analogues tool into local adaptation planning with community leaders in Colombia in Popayan municipality of Cauca Department. Currently, the project is on hold at Ecohabitats, as CIAT is adapting the Climate Analogues tool further to the needs of the project. The goal is that the tool not only allows to identify similar climatic characteristics between sites, but also to compare other biophysical and socio-cultural indicators such as: soil, relief, land cover, organizational forms, poverty indicators, vulnerability indicators, land use suitability, types of production systems, road infrastructure. During January and February 2017, Ecohábitats researchers will develop a model of biophysical and socioeconomic indicators for the identification of municipalities with characteristics similar to the area of TeSAC (based on map algebra); and a student of the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) will develop scaling strategies during the first semester (January to June) using analogues information as an input.

Contribution description

In 2016, Fundación Ecohabitats learned about CCAFS Climate Analogues tool through their partnership with CCAFS regarding Climate Smart Village work in Cauca, Colombia in 2016. The work is supported under CCAFS Flagship 2 by the team of Osana Bonilla-Findji, Science Officer for the CCAFS Climate Smart Agricultural Practices Flagship and by Deissy Martinez-Baron, Science Officer for CCAFS Latin America, CIAT, Cali, Colombia. In February 1st, 2016, there was a training workshop organized by CIAT-CCAFS for 10 participants from Fundación Ecohabitats, Departmental Government of Cauca, Chamber of commerce of Cauca, National Geological Service and CIAT.

Significance of the change

The results of the Climate Analogues work will be used to support the prioritization of areas susceptible for scaling out the Climate Smart Agriculture (CSA) and Climate Smart Villages (CSV) approach in Colombia. CCAFS is leading the implementation of the CSV approach in Cauca, which is being coordinated at local level by Ecohabitats and supported by CIAT. In 2017, a research began on strategies to scale CSA options tested in the Cauca CSV using as one of the inputs the analysis provided by Climate Analogues. The latter is work in progress and expected to end during the second semester. There are no results generated yet, but while keeping in mind the assumptions and scope of the tool, the team at Ecohabitats believes that it will provide very useful inputs to decision making in research and the research results will potentially inform government planning decisions.

Importance of contribution

According to Luis A. Ortega-Fernandez, the Climate Analogues tool was helpful during the initial analyses providing useful insights in terms of climate and allowing a regional level of identification areas for the search. Further, it helped the team to realize that they had to deepen the analysis of climate analogues, using other biophysical and socioeconomic variables as well, which allowed them to compare similar sites not only with respect to climatic, but also to eco-regional, cultural and political characteristics. Lack of human and time resources first did not allow inclusion such additional data, thus the use of the tool in 2016 was useful to identify climatic similarities among areas, however it was limited in order to generate socioeconomic and environmental similarities. Luis A. Ortega-Fernandez believes that the Climate Analogues tool will provide useful input to plan and guide further actions that need to take into account climate, as well as other dimensions, making it easier to prioritize areas with some similarities.
3. ‘Farms of the Future’ extended outcome narrative (B10)

Farmers in East and West Africa participate in the CCAFS ‘Farms of the Future’ knowledge exchange visits to learn about and adopt new farming practices and technologies aimed at strengthening communities’ resilience and adaptive capacity in the face of plausible novel future climates.

Authors:

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**Figure 1**: In May 2012, 15 farmers and 5 key agricultural stakeholders from Lushoto Climate Smart Village, Tanzania, took part in a 10-day learning journey to five climate analogue learning sites culminating in Mbinga district. Learning experiences at these sites included the tree nurseries in Mwitikilwa, improved stoves in Sepukila, beekeeping in Mtama and avocado, banana, and maize trials in Nyombo village. Implementation: NRI and the CCAFS East Africa team.

**Figure 2**: In 2012, 18 farmers and 7 other agriculture stakeholders (18 men and 7 women) from the Lawra-Jirapa Climate-Smart Village site visited farmers in the climate analogue sites Leo and Po in the south-western part of Burkina Faso. Learning experiences included cassava food processing; soil and water conservation and integrated agro-forestry; land issues and farmer organizations. Implementation: NRI, CSIR-ARI (Council for Scientific and Industrial Research) and the CCAFS West Africa team.

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Introductory note

Scientific evidence gathered in the last couple of decades suggests that climate conditions are changing rapidly and that this trend will likely continue and even accelerate. As climate migrates among regions it will disproportionally affect poor and marginalized farmers that depend on agriculture for their livelihoods. Communities, policy makers and scientists need to learn, faster than ever, how to enhance their adaptive capacities to better respond to plausible novel future climates.

Outcome description

Between 2012 and 2014, about 60 farmers and other agricultural stakeholders from East Africa (Tanzania, Kenya) and 200 from West Africa (Burkina Faso, Ghana, Mali, Niger, Senegal) participated in the ‘Farms of the Future’ (FotF) approach led by CCAFS and implemented by regional teams and partner organisations in East- and West-Africa. The project employed the CCAFS’ Climate Analogues tool to model climate projections in 2030 and connect farmers from CCAFS sites to their plausible future climates. Learning workshops served as a way to foster knowledge sharing and critical thinking, to evaluate whether successful adaptation options in one place are transferrable to future climatic analogue site (i.e., areas whose climate today appears to be similar to the future projected climate of a reference location). Farmers from the CCAFS site communities, as well as agricultural stakeholders including district extension, community development officers, NGOs and input suppliers, were then encouraged to take part in learning visits to a range of climate analogue farms to envisage what their climate and farming systems might look like in the future and how other farmers there are already coping with this climate and to facilitate the sharing of knowledge and practices in climate smart agriculture (CSA). These learning journeys and transfer of experiences resulted in changing farmer’s attitudes (e.g increasing women’s self-confidence) and in several communities adopting technologies and innovations that were expected to improve their current livelihoods and adaptive capacity to climate variability and change.

Piloting the Farms of the Future approach in East and West Africa

In 2012, the approach was piloted in Tanzania and Ghana involving farming communities from two CCAFS sites where place-based research on climate change, agriculture and food security was ongoing. The objectives of the pilot studies were to

i) develop and validate the methodology as a means of strengthening the adaptive capacity of farmers and other stakeholders; and

ii) improve the understanding of local practices and available tools for enabling change, as well as cultural, economic, or institutional obstacles to such adaptive change.

The approach facilitated a shared learning process involving workshops with agricultural stakeholders from the region to identify climate analogue sites using the Analogue tool and local knowledge of the participants; the planning and realization of study tours/learning journeys to the selected range of analogue sites; in some cases, the video training of some farmers participating in these tours for them to capture their learning; the sharing of these films with the CCAFS site communities; and the feeding of community sparking reflections on future horizons, increasing farmers and others stakeholders ‘awareness of expected climate change and possible technological and institutional adaptation solutions that can already be undertaken.

In Tanzania in 2012/05, 15 farmers and 5 key agricultural stakeholders from the villages Mbuzii and Yamba in the Lushoto district in the Northern highlands of Tanzania took part in a 10-day learning journey to five climate analogue learning sites culminating in Mbinga district in the Southern highlands. Learning experiences at these sites included the tree nurseries in Mwitikilwa; improved stoves

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5 Now referred to as “Climate-Smart Villages”
6 The approach was also piloted in Nepal in 2012, the results of which are not discussed here (see CCAFS blog on the pilot study and on the lessons learned).
in Sepukila; beekeeping in Mtama; and avocado, banana, and maize trials in Nyombo village. (see CGIAR news blog) and learning video).

**In Ghana in 2012/10,** 18 farmers and 7 other agriculture stakeholders (18 men and 7 women) from Doggoh and Bompari in the Lawra and Jirapa districts participated in the project and visited farmers in the climate analogue sites Leo and Po in the south-western part of Burkina Faso. Learning experiences included cassava food processing; soil and water conservation and integrated agro-forestry; land issues and farmer organisations (see learning video).

The participating farmers appreciated these learning opportunities and some signalised that they intended to adopt some of the new practices. General insights from these pilot studies were that the methodology principally was a successful learning tool (not meant to be a predictive one) seeking to strengthen farmer adaptive capacity. The lessons learned included that: Significant opportunities exist for more stakeholder to stakeholder learning on adaptation using this approach; Gender-based study tours represent a major opportunity to show women and men that gender roles are not fixed and that changes can bring positive benefits for the entire family;

More support should be provided for good quality facilitation of participatory action research to explore future scenarios amongst farmers and wider agricultural stakeholders, using the climate analogue tool, but emphasizing the ground-truthing and combining this with training on technical skills and equipment for video making. But most importantly these experiences allowed to highlight and illustrate that, building adaptive capacity required institutional, structural and policy change and a strong engagement of actors across the agricultural innovation system as this strengthening could not be achieved by farmers alone (see CCAFS FotF presentation).

**Scaling out in West Africa**

Several regional initiatives in West Africa with goals beyond the methodological testing of the FotF approach followed and were incorporated in other programs and processes in West Africa:

A series of regional training workshops were organized, including one at the AFRICA HALL conference room in Niamey, Niger from 3rd to 5th October 2013 with 35 representatives from Burkina Faso, Ghana, Mali, Niger and Senegal. The workshops aimed at building technical stakeholders’ capacity on the use of the Climate Analogues tool and the FotF approach to improve the adaptive capacity to climate changes.

The Niger workshop was followed by the implementation of the FotF approach in Burkina Faso and Niger under CCAFS activities in December 2013. At the same time, FotF was launched in Mali and Senegal, and in June 2014 at a further location in Ghana under the project "Enhancing the Resilience and Adaptive Capacity to Climate Change of farmers in semi-arid West Africa (ENRACCA-WA)" in collaboration with other regional research institutes and National Agricultural Research Systems (see CCAFS blog on scaling the FotF approach):

In **Burkina Faso** in 2013/12, 34 persons including 20 farmers (10 women and 10 men) from Tibenga were led by André B. Bationo (INERA) to their climate analogues sites Ziga, Reka, and Bilinga in the Oula district (see learning video).

In **Niger** in 2013/12, the project was led by Abasse Tougiani (INRAN); 20 farmers (10 women and 10 men) from Kampa-Zarma visited Iskita and Guidan Dimauo.

In **Mali** in 2013/12, FotF activities were led by Ibrahim N’Diaye (IER) at two sites:

i) Soké, where 22 farmers (10 women and 12 men) participated in learning visits to Sibougou Wéré and Bogossoni

ii) Bamadougou, where 20 farmers (10 women and 10 men) participated in learning visits to Banco (see learning video).
In Senegal in 2013/12, the project was led by Diaminatou Sanogo (ISRA) also at two sites 

i) Tattaguine, where 20 farmers (5 women and 15 men), two 2 extensionists (ANCAR, service des Eaux et Forêts) and 2 conseillers ruraux visited the villages Keur Metoune, Fem Boul, Sathre Sy and Sam dieng, 2 extensionists (ANCAR, service des Eaux et Forêts) and two rural advisors. (see learning video).

ii) Nouye-Daga Birame, Kaffrine region, where a total of 30 persons including 21 farmers (10 women and 11 men), three AIS agents (all men), four researchers (1 woman and 3 men), and two policy makers at local level (1 woman and 1 man) visited Dahra, Linguère, and Mbar-Toubab in Senegal.

In Ghana in 2014/06, Alhassan Lansah Abdulai (CSIR/SARI) led participants from Demonaayili including 18 farmers and 7 extensionists to the analogues site Takorodo.

Scaling out in East Africa, Kenya

In 2014/11, the FotF approach was also rolled out in Kenya, Nyando district, where 16 farmers and 7 other agricultural stakeholders from Kapsorok and Kamwana villages participated in an eight days learning journey visiting farmers across different agro-ecological zones in 12 counties (see CCAFS news blog, presentation, and learning video).

Uptake of new farming practices

In 2016, an assessment of the uptake of climate-smart agriculture technologies and practices in Lushoto district, Tanzania, found that “farmers acknowledged the FotF approach as a useful tool that enabled them to interact with other farmers and learn new CSA practices and innovations”. Respective statements were also made at other sites. For example, Michael Ogara, a farmer from Kamuana Village, Nyando, Kenya, said: “I have learned a lot during these 6 days of learning. I learned how to prepare mango tree nursery, how to graft mango stocks that are drought and disease resistant with good quality and high yielding scions. I also learned that mango trees need fertilization at least every three months to increase increased fruit production. I intend to start with 20 grafted mango seedlings on my farm and train about 30 other farmers.”

Examples for the uptake of new farming practices include

- In Burkina Faso, farmers from Tibtenga started implementing half-moon farming techniques based on what they saw in their analogue site Reka during the farmers exchange visits.

- In Senegal, women from Daga Birame started processing the baobab fruit based on what they learned from the exchange visit. In addition, the community established a protected area to protect natural vegetation in general but also the baobab tree in order to sustain the activity of processing baobab fruit powder developed by women (see Daga Birame case study).

Knowledge was shared both ways, i.e. visitors learned from their hosts and vice versa, for example

- In Ghana, farmers from both the reference site Demonayili and the analogue site Takorodo grow yam as their main crop, but they use very different farming practices. The visitors from Demonayili learned from their hosts in Takorodo that yam can be produced well on old farms, including maize farms, which generally received fertilization which as an after-effect improves the yam yields. The hosts, in turn, received advice from their visitors how to reduce the amount of herbicides used to control weeds in order not to harm the environment but still retrieve good yam yields (see CCAFS blog).
Contribution description

Development of the approach

During 2011, the Climate Analogue methodology and broad application concept was jointly developed by the International Center for Tropical Agriculture (CIAT, a CGIAR center), the Walker Institute at the University of Reading, U.K. and the Climate Impacts Group at the University of Leeds, U.K., commissioned by CCAFS. The tool is coded entirely as a library for the R environment for statistical computing. The methodology has been published in 2011 and is explained on the CCAFS website. CCAFS provides two platforms to apply the Climate Analogues approach: i) the Climate Analogues online tool as a user-friendly and readily accessible platform that will facilitate quick identification of likely analogue sites; and ii) the Climate Analogues R-package, which allows a more detailed analysis to be performed with the potential introduction of user defined data and improved uncertainty quantification.

As one application of the Climate Analogues tool, Andrew Jarvis and Osana Bonilla-Findji, both from CCAFS/CIAT, developed the Farms of the Future approach in 2011 as part of the research portfolio of the CCAFS Adaptation to climate change theme (the current CCAFS Flagship 2 on CSA Practices and Technologies). The on the ground application and testing of this approach in Africa was then carried out in partnership with the Natural Resources Institute of the University of Greenwich (NRI, a CGIAR partner), national partners in Tanzania and Ghana and the support from CCAFS regional teams.

Project coordination and management

The East and West Africa FotF pilots were coordinated by Valerie Nelson and Richard Lamboll from NRI and Nick Nathaniels, an independent consultant engaged for the participatory video element. All work including the farm-to-farm exchange visits were paid by CCAFS Flagship 1 and regional teams budgets.

In the Tanzania pilot, the CCAFS regional staff (Maren Radeny and Catherine Mungai, ILRI) and Lebai Nsemwa, George Sayula and Juma Wickama were the lead facilitation team.

In the Ghana pilot, the lead facilitators were Jesse Naab, CCAFS site coordinator and Matthew Zaabelle, the Ghana participatory video coordinator. Abdoulaye Moussa, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and CCAFS West Africa regional coordinator, played a key role in coordinating the parties and participated in the study tour.

The leads coordinating the learning visits in the 2013/14 scaling out of the FotF approach in West Africa were Mathieu Ouedraogo (CCAFS West Africa), André B. Bationo (INERA) in Burkina Faso, Abasse Tougiangi (INRAN) in Niger; Ibrahim N'Diaye (IER) in Mali; Diaminatou Sanogo (ISRA) in Senegal; and Alhassan Lansah Abdulai (CSIR/SARI) in Ghana.

In Kenya, the CCAFS regional staff (Maren Radeny, Mary Nyasimi), Philip Kimeli (ILRI), Wilson Aore (KALRO), and Reuben Chirchir (Ministry of Agriculture) participated in the planning and study tour respectively.

Implementation of the FotF approach

Work at all pilot sites built on the CCAFS researchers and partners presence at these CCAFS locations (CCAFS’ “Climate-Smart Village sites”) and thus benefitted from substantial knowledge of the local situation and good connections to local stakeholders.

Implementing the FotF approach included a complex bouquet of factors and actors contributing to the process/project and its findings:

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7 Researcher/PV trainer ARI Uyole and Farms of the Future Local Media Facilitator
8 Agricultural Research Officer, SARI and CCAFS Local Site Team Leader
9 African Highlands Initiative, Lushoto – Study Tour Facilitator
The development, training and use of the Climate Analogues tool both as a method to identify plausible climate analogue sites and as a learning tool aiming to increase adaptive capacity and awareness of climate change;

The organisation and implementation of planning and learning workshops connecting stakeholders of diverse background; this included the workshop in Niger with international participants and several others in East Africa;

Facilitation of learning journeys enabling stakeholder exchanges from various climate analogue sites;

Provision of technical equipment and training on preparing videos to capture and share learning.

Sharing of findings and lessons learned

Sharing of results, experiences and lessons learned during the implementation of the FotF approach and the use of the Climate Analogues tool for this took place through local and international workshops such as that in Niamey, Niger in October 2013 which was initiated by CCAFS West Africa and the Institute for Sahel (INSAH). In addition, there were numerous papers (publications, online blogs; presentations; project progress and meeting reports; posters, guidelines, manuals) produced on the approach generally and the activities and the results at the local sites (see links in this document); there are also assessments of achievements including

- The NRI synthesis report on the pilots in Tanzania and Ghana;
- The assessment of the FotF work in Lushoto, Tanzania (CCAFS Working Paper No. 173);
- Info notes e.g. on the work in Mali, Senegal, and Niger; and a
- Policy note on the achievements in Senegal

Significance of outcome

One of the objectives of the FotF project was to develop and validate the methodology - including the use of the Climate Analogues tool as part of engaging communities in learning journeys to climate analogue locations – as a means to ultimately inspire them from their peers and strengthen their adaptive capacity to a changing climate. Capacity building has various dimensions: changes in awareness; in culture and values; in resources; and in formal or institutional support. The Tanzania/Ghana project team acknowledged that their study was not expected to achieve progress in all of these, but found that “ideas could be seeded and more information gained that could later contribute to these goals. [...] In particular the study tour appears to help in relation to [...] consciousness of climate change and the need to act….” (Tanzania Report 2014, p28).

Importantly, the FotF pilots in Tanzania and Ghana in 2012 showed that there was a need for change both at the individual and the household level, as well as at the broader, systemic level. Adaptive capacity strengthening could not be achieved by farmers alone, it required institutional, structural and policy change, as well as a strong engagement of actors across the agricultural innovation system. Also, in Lushoto, Tanzania, it was found that despite a deliberate attempt to have many women farmers participating, this was difficult given their roles and responsibilities at home. This was observed, too, in the Nyando, Kenya work in 2014.

The 2014 NRI synthesis report on the Tanzania and Ghana pilots concluded that “the Farms of the Future approach, combining climate modelling/analogue tool, farmer study tours, and participatory video, can support adaptive capacity strengthening when embedded in a participatory research process. A short-term initiative is unlikely to shift entrenched norms and structural barriers to adaptation, but it can help to introduce ideas about longer term climate change, and build greater consciousness of climate change challenges, opportunities and awareness of the need to act. It can help to articulate demand for action from farmers and other stakeholders in the agricultural innovation system and support reflection amongst participants on what poten-
tial future scenarios might look like.” The report further suggested that “to more fully understand the outcomes of the pilot requires a follow up ex-post evaluation to explore whether the study tour sparked new thinking and practical action, assess its contribution to an overall participatory action research process, including identification of the social and cultural barriers to adaptation.”

So far, there are no follow up outcome assessments yet at the sites in West Africa and in Kenya, Nyando, examining to what extent learning has taken place and sustainable changes have materialized improving the adaptive capacity of communities to climate change. There is, however, a study published in 2016 on the effectiveness of the FotF approach and the uptake and dissemination pathways for climate-smart agriculture technologies and practices in Lushoto, Tanzania (see 2016 assessment). Using household survey data, complimented with qualitative information from focus group discussions and key informant interviews, the 2016 assessment showed that “farmers are using a variety of CSA technologies and practices, and institutional innovations. Improved crop varieties, agroforestry, and scientific weather forecast information were cited as the main CSA practices used. To minimize their risks and reduce vulnerabilities, farmers are diversifying and integrating five to ten practices in one season. [...]. Over 95% of the farmers reported receiving agricultural information orally from a variety of sources including government extension workers, seed companies, researchers, traditional experts, neighbors, radio agricultural shows, religious groups, farmer groups, and family members.”

Overall this novel anthropological approach of farmer-to-farmer exchanges between spatial analogues has been helping to improve the understanding of social and cultural perceptions of future climates, local practices as well as the cultural, socio-economic and/or institutional barriers that might need to be overcome for enabling adaptive change.

CCAFS plans to implement the FotF approach also in the future, for example, in several villages in Mali in the context of the DFID funded ‘Building Resilience and Adaptation to Climate Extremes and Disasters’ (BRACED) program together with ‘International Relief and Development’ (IRD) and in collaboration with its partner ICRISAT.

Finally, the FotF work has also inspired other, non-CGIAR organisations to use the approach in their work: learning about the tool from their partner NRI, the INGO ‘Concern Worldwide’ has been using the Climate Analogues tool to identify climate analogue sites and conducting farm-to-farm visits e.g. in their work in Sierra Leone (see outcome PW1).

Importance of contribution

**Contribution of the FotF approach to strengthening farmers’ adaptive capacity**

The farm-to-farm exchanges designed and carried out in the context of the FotF approach brought new knowledge to the communities of the participating CCAFS sites in East and West Africa. It brought in technical and institutional innovations/initiatives adopted by the “traveling” farmers that were then shared in their communities. The results from the implementation of the FotF approach showed how farmer exchanges, embedded in a program to develop capacity for planning and decision-making under uncertainty and change, can be used as a critical tool for setting the basis for more tangible exploratory scenarios exercises that enable communities to envisage their future and think critically about it, and encourage them to initiate immediate actions. It was evident from farmers’ testimonies that these exchanges and practical learning experiences were powerful mind changers that helped them to begin to read the world differently.

The effectiveness of farm-to-farm visits was also recognized in the NRI synthesis report 2014, where it was concluded that study tours or learning journeys are a valuable tool contributing to programs seeking to strengthen farmer adaptive capacity, particularly if embedded within a participatory action research process and accompanied by institutional support, extensive capacity building, and structural and policy changes.
**Contribution of the Climate Analogues tool to the FotF approach**

The climate Analogue tool was useful in getting a rapid assessment at a low cost to establish plausible scenarios using the best of our climate information. There are however, clear limitations i) of the existing climate information that is available to validate the models, and ii) concerning the degree that other factors than temperature and precipitation have an influence on farmers decision making processes about land management practices and planning.

1. **Addressing the uncertainties of climate modelling/projections:** Climate modelling/projections have inherent uncertainties, especially in highly dissected landscape situations, and there is always a range of future climate scenarios. With full consideration of the technical (and ethical) implications of this, the climate change training and future scenarios planning exercises carried out in the context of the FoTF exchanges were deliberately designed to be informative and forthcoming about the uncertainties inherent to the climate models used. It was ensured that there was sufficient communication to responsibly explain the selection of the analogue sites and the concepts of environmental change.

The outputs from the Analogue tool informed exploratory scenarios exercises with the communities that grounded these model outputs into a broader context. This crucial process allowed a better understanding and consideration of the limitations of adequately predicting and accounting for all the sources of change that can affect future community development and the social, economic and environmental systems in which they evolve.

2. **Consideration of socio-economic and biophysical factors:** Moreover, climate change and variability are not the most significant factors compared to more immediately recognizable socio-economic (market access, employment availability, political unrest) or biophysical considerations (soil composition, structure and moisture content, topography or water available for irrigation).

Recognizing these limitations of the Climate Analogues tool to be applied in the context of FotF, it was established that to successfully create learning opportunities:

i) **additional criteria** would guide the selection of analogue sites:
   a. biophysical considerations were included such as similarity in topography, soils etc.;
   b. system analyses were performed to select socially, culturally and environmentally appropriate exchange locations (to be able to handle of social, cultural, language, gender barriers, etc.);
   c. the exchange location should offer inspiring learning initiatives promising to be insightful to the visiting farmers;

ii) **a climate journey** – exploring a range of climatic gradient (locations), rather than only one – would be the best way to get farmers to explore a variety of potential climate scenarios;

iii) **Preparatory communication** with the different hosts were needed to ensure clarity on the purpose of the visit which ultimately should provide a bidirectional learning opportunity.

**Conclusions on the contribution of the FotF approach and the Climate Analogues tool**

There are significant benefits demonstrated by this case for using farm-to-farm exchanges as exploratory scenarios rather than as predictions. Visiting multiple diverse plausible futures allows for training and capacity development in strategic planning and decision making under uncertainty and change. Moreover, the approach breaks down people’s assumptions and expectations about their future and what could lead to their vulnerability to a number of specific stressors and changes.

The Climate Analogue tool proved to be useful during the scoping phase of the FotF implementation engaging stakeholders in the ground-truthing of the outputs, sparking critical thinking and finding diverse plausible scenarios with respect to relevant social, cultural, political and environmental variables.
4. ‘Outcome Map’ and outcome narratives of the ‘Seeds for Needs India’ program (A13)
Authors:
Prem Mathur: formerly Regional Representative for Central and South Asia, now Honorary Research Fellow, Bioversity International India
Sarika Mittra: formerly Scientific Officer Bioversity India, now Ph.D. student
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Neeraj Sharma: Scientist, Crop Diversification and Seed Systems, Bioversity India

4.1. Umbrella outcome 1: National government agencies partner with Bioversity/CCAFS for situational analyses, planning and piloting Bioversity’s Seeds for Needs India program.

Importance of the Climate Analogues tool for the achievement of this umbrella outcome, i.e. securing ICAR commitment and co-funding for the pilot and regular PVS/CS trials; and engaging/enabling DWR, IARI and NARC to lead these field trials? (no direct role, low, medium, high importance)? MEDIUM

4.1.1. Outcome SN01a (engagement of ICAR to support S4N, planning)

Outcome statement
In late 2010, the Indian Council of Agricultural Research (ICAR), an autonomous organisation under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India, engaged with Bioversity India in discussions to integrate Bioversity’s ‘Seeds and other Planting Materials for Needs’ program - A Citizen Science Approach for Climate Change Adaptation (Seeds for Needs, S4N) into the ICAR-Bioversity workplan for 2012-2016. ICAR appointed the National Bureau of Plant Genetic Resources (NBPGR), an ICAR institute, as its nodal institution for finalising the ICAR-Bioversity workplan and hence this activity was also discussed with NBPGR staff before the S4N program was agreed and included (the workplan was signed in 2012 by the Director General of both ICAR and Bioversity). This was the first time ICAR agreed to support and co-fund work involving CCAFS’ Climate Analogues tool as part of agreed workplan.

The objectives of the S4N India program were to i) expose farmers to more crops and their varieties and increase their first-hand knowledge about different traits and options available; and ii) strengthen their seed systems and seed-saving capacity so that they always have access to planting material...
that fits their changing needs. To implement the approach, it was planned to establish a farmers-based experimentation network in the Indo-Gangetic Plain (IPG) region of South Asia; the farmers in this network would test and select landraces and varieties identified based on the climate analogue approach; ultimately, it was planned to establish an enhanced seed systems to enable adaptation at community level including Community Seed Banks.

From 2011 up to 2016, ICAR provided a regular annual grant for the implementation of Bioversity-ICAR agreed collaborative projects, including the S4N project. In addition to this in-kind support was provided for their staff time, field trials, use of their field and laboratory facilities, seed multiplication, their packing and distribution, etc.

**Contribution statement**

**Bioversity India** has a close connection with ICAR and its institutes; this longstanding relationship and mutual trust developed among Bioversity India and ICAR helped to **engage the government research organisations** in this new approach employing the CCAFS’ Climate Analogues tool.

The S4N concept was designed by Bioversity and the first project was received from an anonymous donor for Papua New Guinea. Based on this Bioversity developed a proposal together with NBPGR and CCAFS-South Asia based on advice from the CCAFS-South Asia Coordinator, Dr. Pramod Agrawal, that included the use of the Climate Analogues tool. The S4N project in India started 2010 with **CCAFS committing US$ 50,000 for the first pilot phase** for farm participatory climate change adaptation and visualization from 25 August 2010 to 24 June 2011. **The CCAFS Analogue team** at the International Center for Tropical Agriculture (CIAT), namely Andrew Jarvis and Osana Bonilla-Findji, contributed to the project by developing high quality climate data for South Asia, which were used in all analyses throughout the project. Both Andy and Osana also visited the field sites during the first phase of the project in Punjab and Haryana. Andy Jarvis also visited the field site in Bihar.

**Significance of outcome**

The underlying hypothesis and purpose of the S4N program is that crop diversity is essential to respond to challenges of climate change; growing more diversity on farms will thus lead to sustainable agricultural production. The program recognizes the need for mainstreaming diversity on-farm and broadening the genetic-base of farming systems – both at inter and intra-species levels (i.e., promoting growing more crops as well as many varieties of a single crop). With increased information and access to a wide range of crops and varieties, farmers will be able to make better choices according to climatic conditions.

**Importance of contribution**

The **Climate Analogues tool developed by CCAFS** was one component of several climate models, tools and databases the project has taken advantage of, including amongst others also Maxent, FloraMap, Diva-GIS, GBIF, WorldClim. The Climate Analogues tool was chosen for the S4N program as it promised to provide more up-to-date information helping to identify the crop traits and varieties needed to help farmers and breeders at the selected location to adapt to climate change. Other tools, too, had a built-in components to predict climate similarity, but at that time most used old data for climate grids. The Analogue tool developed by CIAT-CCAFS had advanced functionality, where both current as well as future climate datasets could be used and the analysis and outcomes are based on certain assumptions as prescribed by IPCC. Also the Climate Analogues tools allowed the use any of the 24 models or any combinations of these models. Therefore, outcomes of the Climate Analogues tools were considered more reliable for climate matching sites, and hence selection of the varieties was more appropriate based on comparing the climate of the past vs past, future vs future and past vs future. ICAR scientists were aware of the use of the Climate Analogues tool, but had never used it before and were keen to test it in partnership with Bioversity International.
The S4N selection of varieties was based on both, the use of the Climate Analogues tools and also taking into account datasets for the past performance of the varieties in various field trials in different climate conditions.

4.1.2. Outcome SN01b
(first pilot trial, wheat, led by DWR, 80 farmers in Punjab, Haryana, Uttar Pradesh, Bihar)

Outcome statement

The Directorate of Wheat Research (DWR) of the Indian Council of Agricultural Research (ICAR), Karnal, Haryana, coordinated the first pilot trial on wheat for on-farm participatory climate change adaptation and visualization from 25 August 2010 to 24 June 2011. DWR supported by Bioversity identified the locations and convinced the farmers to participate, an incentive being that they could keep the yield from the tested seeds. Ten wheat varieties were selected for the farmers’ field trial and the field trials were conducted across four locations in the IGP region of India, two sites in each the North West IGP region (Ludhiana, Punjab and Karnal, Haryana) and the North East IGP region (Varanasi, Uttar Pradesh and Pusa, Bihar). 80 farmers were selected to undertake these field trials, 20 at each project site.

Contribution statement

The first pilot phase was funded by CCAFS (see SN01a) and ICAR contributed both in-kind and cash contributions in terms of their staff time, seed packing and their distribution for farmers field trials, seed materials, etc. For the field trials, the 10 varieties were carefully selected by Bioversity India and DWR scientists with a mixed approach involving use of the Climate Analogues tool, assessing the performance of these varieties in similar climatic zones, both at the present and in the past. This was done by looking at the database of the ‘All India Coordinated Trials’ for wheat released from 1977 to 2006.

Once the 10 varieties and their source were identified, Bioversity supported the regular monitoring of the field trials jointly with the staff of DWR. Farmers field days were organised, where many farmers were invited to visit the performance of these varieties and in compiling and analysing the data and submitting final technical report to CCAFS.

Significance of outcome

Based on the outcome of the wheat pilot project, it was observed that most of the selected varieties outperformed those, which farmers were cultivating over the years and farmers were happy to continue to grow some of the selected varieties as per their choice. The choice varied from location to location and from farmer to farmer.

Importance of contribution

Normally, farmers source and cultivate varieties that are available at their local markets from both public and private sources. However, these agencies sell only seeds varieties bred, tested and released for their particular agro-climatic conditions, so farmers normally do not have access to other seed material. Based on the Climate Analogues / GIS analyses, the Bioversity selection strategy included a diverse genetic set of varieties:

- 60% of varieties selected for the same agro-climatic conditions, either presently or in the past over 20 to 30 years; some of these were good in the past but had been replaced by new varieties and thus were not available any longer;
- 20% of varieties selected which were released for other agro-climatic region of the country, but the scientists suggested that these varieties might also do well at the project sites;
- 20% of varieties being randomly selected.
The selection included some very good, high quality varieties which performed well and were recognised for specific traits. This convinced the farmers to continue with the trials and start selecting seeds by themselves.

4.1.3. Outcome SN01c (second pilot trials: wheat led by DWR, rice led by IARI in India and NARC in Nepal)

**Outcome statement**

In 2011, following the success of the wheat field trials and the interest shown by farmers and communities, a second round of field trials started both for wheat and rice varieties, involving three government partners that helped coordinating the trials:

1. **DWR** continued to be involved in the selection of seed varieties and monitoring of a second cycle of field trials in partnership with the Indian Agricultural Research Institute’ (IARI) of ICAR.

2. **IARI** coordinated the second cycle of wheat pilot trials to test the results of the first year trials with wheat farmers across two of the project sites during 2010/2011 (Pusa and Karnal; Ludhiana and Varanasi were dropped). **IARI also led a pilot trial on rice** through its regional station located at Pusa, Bihar, testing the varieties across the same locations as the wheat trials 2010/2011 (except Varanasi). Since the projects progressed well, IARI got more actively involved providing office space to Bioversity for coordinating the entire S4N work in India. Packing of all trials for S4N work were done from the office in Pusa, Bihar. IARI contributed both in-kind and cash contributions in terms of their staff time, seed packing and their distribution for farmers field trials, seed materials, etc.

3. In Nepal, the **rice improvement program based at Parwanipur experimental station of the ‘Nepal Agricultural Research Council’ (NARC), committed to partner also in a pilot trial with rice**. They engaged rice growing farmers in Parwanipur to test 10 varieties of rice during the rice growing season of 2011.

**Contribution statement**

Bioversity used its tools box including the Climate Analogues tool to help DWR and IARI identify 21 high yielding wheat varieties and 50 germplasm that had been tested and released in India and 10 high yielding rice varieties that had been tested and released in India and Nepal. The varieties chosen for the trial sites included past and current released varieties and/or from an agro-climatic region different from the trial site. Bioversity also assisted to organise farmers’ fairs, performed data analyses and submitted reports to CCAFS.

**CCAFS** provided another grant of US$ 50,000 for the second cycle of rice and wheat pilot trials. The S4N program for Nepal was also prepared and developed with technical input from CCAFS-South Asia Office.

**Significance of outcome**

The success of the trials led to a growing network of participating farmers and their willingness to get more involved (seed sharing and community seed banks, see SN09). Further it convinced ICAR to commit to further funding and expand the project to further sites (see SN08).

**Importance of contribution**

The successful selection of high yield wheat and rice varieties, partly informed on the Climate Analogues/GIS analyses, was an important factor convincing the farmers to participate in the program. Bioversity was still doing all analyses, DWR, IARI and NARC did not employ the GIS software or Climate Analogues tool. However, policy level staff directly involved in selecting the seed varieties, such as DWR, became aware of the tools and their role and significance in selecting these climate-ready seed varieties.
4.1.4. Outcome SN01d (regular field trials: PVS & CS)

Outcome statement
In 2012, following the successful pilot trials, the local agricultural extension systems (Krishi Vigyan Kendra, KVK) of ICAR agreed to assist in regular field trials. The pilot trials had consisted of un-replicated, large number of trials in small plots and these were primarily evaluation of germplasm from the genebanks. High yielding varieties, notified and released by the national system were also included in the trials. The regular trials starting in 2012 were the Participatory Varietal Selection (PVS) trials and the crowdsourcing (CS) trials; here seeds were distributed to the farmers to be planted in their farms and they were asked to give feedback about the performance. The varieties which were released / notified and also which performed well in the farmers’ fields (in comparison to the varieties that are currently grown by the farmers) were selected for trials again in the next season. In these regular trials, the sites for the wheat and rice trials were those that were already chosen during the pilot trials. A few sites were dropped because Bioversity felt fewer sites would be more effective based on logistics and resources.

Contribution statement
For implementing these programmes, Bioversity worked very closely in collaboration with the local agricultural extension systems (KVKs) and most of the PVS and CS trials were conducted by them, except at the Bioversity/CCAFS trial sites in Bihar (Vaishali), where their own staff was hired and a farmers network existed. The KVKs are part of the ICAR system and can be located either with an ICAR institute, a State Agriculture University, or an NGO. Bioversity worked with KVKs administered through all three types of entities. The ICAR staff of the KVKs continued to engage the farmers and were also instrumental in helping Bioversity to finalise the variety list.

Similar to the pilot trials in 2011, Bioversity India used the Climate Analogues tool to identify new wheat varieties to be tested. Climate Analogues played a role in this in combination with matching varieties performances in different agro-climatic conditions based on available date.

Significance of outcome
The regular trials (PVS and CS) exposed the farmers to a lot of varieties which were not accessible by the farmers till then. They were growing only the varieties which were available in the not-so-well-developed seed systems in the interior rural areas. Now seeing so many varieties and their performances had a good impact on their existing knowledge about crop varieties (wheat and rice primarily). The farmers were told that they could save the varieties they liked in the CS or PVS trials for planting in the next generation. This solved the issue of non-availability of different varieties. Training was imparted to them for producing good quality seeds so that the selection-production-sowing continuum can happen seamlessly. This is how the system was mainstreamed.

Importance of contribution
Like in the pilot trials, the Climate Analogues Tool developed by CCAFS was used by Bioversity (as part of the tool box) to identify the crop traits and varieties needed to help farmers and breeders at the selected location to adapt to climate change.
4.2. Umbrella outcome 2: The National Seed Bank NBPGR builds capacity in CC analysis and identification of seed varieties; they start acquiring varieties integrating climate analogue information, and test and disseminate these.

Importance of the Climate Analogues tool for the achievement of this outcome: engaging and building capacity in the NBPGR (no direct role, low, medium, high importance)? MEDIUM

4.2.1. Outcome SN02

Outcome statement
In 2012, after the success of the first pilot trials, the genebank at the National Bureau of Plant Genetic Resources (NBPGR), India, one of the largest genebanks in the world in terms of ex situ collections, for the first time integrated climate analogue information to decide on the accession of crop species. The NBPGR employed the Climate Analogues tool, clustering their accessions based on agro-climatic zones in India, to identify pre-adapted germplasm in five selected crops — wheat, pearl millet, chickpea, pigeon pea and sorghum. Rice was dropped since it is India's pre-eminent crop and the project would have taken too many resources (it was taken up again later, after the project, together with other crops). The methodology comprised geo-referencing and clustering the accessions, identifying vulnerable areas, designating pre-adapted material, collecting and conserving germplasm from predicted sites, and developing a database and climate maps. Genebank accessions were listed as climate ready to be utilized directly as varieties or as parents in breeding depending upon agronomic performance in such vulnerable sites. From 2012 to present, the Climate Analogues tool is being used routinely as part of the basic screening of the accessions of NBPGR.

The objectives of this joint project with NBPGR were
1. classification and mapping of ex situ collections, diversity analysis and publication of crop germplasm atlas;
2. understanding the degree to which promising genebank collections can help farmers cope with climate change;
3. evaluating and validating the suitability of the Climate Analogues approach for facilitating climate change adaptation,
4. identification of analogue sites for future environments for each target crop, and
5. development of a national database for selecting germplasm accessions for climate adaptation.

Contribution statement
Bioversity India, via its close connection with ICAR, had an established relationship with NBPGR as an ICAR institute; Bioversity staff worked hand-in-hand with NBPGR staff, providing training on the use of GIS softwares (e.g. DIVA-GIS), GPS hand-held units, spatial modeling tools (e.g. Maxent, FloraMap), assisting them to geo-reference and cluster their collections, which so far had not been done. The geo-referenced data was then spatially analysed to find clusters, make diversity assessments and identify gaps in collection. The climate at the collection sites were matched to identify vulnerable sites and their analogues using the Climate Analogues tool. Based on the overall results, Bioversity/ICAR's conducted collecting missions throughout India.

CCAFS contributed US$ 250,000 to the project “Utilization of ex situ collections using climate analogues for enhancing adaptive capacity to climate change in South Asia” which was used for institutional and individual capacity building in the NBPGR.

Significance of outcome
This was the first time an ICAR institute employed the Climate Analogues methodology - before it was Bioversity employing the tool. It was the real starting point including Climate Analogues into the project. The main benefits include individual and institutional capacity building, i.e. the addition of a
climate attributes layer to the existing Plant Genetic Resources (PGR) informatics set up at the NBPGR. It demonstrated the potential of the Climate Analogues tool to add value to the conserved germplasm and to identify vulnerable sites.

Using the Climate Analogues tool together with the other tools mentioned above, NBPGGR is now regularly updating their geo-reference information to their past collections and mapping these collections on NBPGGR portal. Once geo-reference, they cluster and identified climate ready collections. Further, while re-collection missions were done for all five crops, further sampling and evaluation of the new accessions for their suitability was thought to be necessary. These are now being planned based on gap analyses of the existing collections. In addition, recollections are being done from threatened areas which may not be suitable in future for the current crops based on the Climate Analogues analysis.

Overall, the project contributed to the following five outcomes
1. Increased access to crop diversity information and materials;
2. Increase resilience of agricultural systems;
3. Stakeholders’ capacities strengthened,
4. Adaptive germplasm identified, multiplied and distributed, and
5. Trained staff for the use of Homologue-Analogue tools.

Importance of contribution
Allowing the identification of climate pre-adapted germplasm as well as locations where crop diversity might be at risk due to a changing climate, the Climate Analogues tool added another layer to the accession screening of the NBPGR, directly influencing the decision process, so that endangered genetic resources can be collected and conserved. The tool is still being used today for accession screening at the NBPGR.

4.3. Umbrella outcome 3: Local extension services (KVK) support field trials providing seed materials, maintaining trials in good condition and educating farmers on field practices as necessary.

Importance of the Climate Analogues tool for the achievement of this outcome: engaging and building capacity in KVKs so that they can better implement the S4N trials (no direct role, low, medium, high importance)? No direct role

4.3.1. Outcome SN03

Outcome statement
The local agricultural extension systems (Krishi Vigyan Kendra, KVK) of the ICAR implement most of the regular (PVS and CS) trials since 2012, except at the Bioversity/CCAFS trial sites in Bihar (Vaishali), where Bioversity has established its own network of farmers. The KVKs also supported Biodiversity in capacity building in other partners (NGOs).

Contribution statement
Bioversity worked closely with the KVK systems, training them in how to lay out and maintain the field trial, and how to capture data using the ODK software on the mobile devices (see SN07).
Significance of outcome
The work of the local ICAR extension systems ensured that capacity was built and policies were developed that supported the expansion of the program and the involvement of farmers at a scale that would otherwise not be possible.

Importance of contribution
Climate Analogues did not play a direct role in this work.

4.4. Umbrella outcome 4: Universities support the S4N program through hosting the local extension services (KVKs) and take part in capacity building activities

Importance of the Climate Analogues tool for the achievement of this outcome: engaging and building capacity in universities so that they can better coordinate and help implement the S4N trials (no direct role, low, medium, high importance)? Low

4.4.1. Outcome SN04

Outcome statement
In addition to ICAR institutes, many of the State Agricultural Universities also contributed significantly. Partner universities were the Punjab Agricultural University (PAU), Ludhiana, Punjab; and the Banaras Hindu University (BHU), Varanasi, Uttar Pradesh. They hosted the KVKs and thus supported coordination and implementation of the pilot and regular field trials and provided quality seed materials which they had developed. Academic staff also participated in capacity training and showed an interest in using the GIS and the Climate Analogues tools for their scientific work and publications (through currently there are none).

Contribution statement
The collaboration with the universities was initiated by Bioversity and capacity training delivered by Bioversity staff.

Significance of outcome
Universities were involved in the S4N program mainly because they were the hosts of the ICAR-KVKs. They did not use the Climate Analogues and/or other tools for selecting promising seeds or other purposes. However, they became aware of the tools and were keen to use it for their academic work.

Importance of contribution
Climate Analogues was used in capacity training and stimulated an interest do include the tools in academic research. The training lifted reservations that these tools are expensive and difficult to use have been lifted and they are now aware that the tools are free and easy to use.
4.5. Umbrella outcome 5: NGOs support the S4N program through hosting the local extension services (KVKs)

Importance of the Climate Analogues tool for the achievement of this outcome: engaging and building capacity in local NGOs so that they can better coordinate and help implement the S4N trials (no direct role, low, medium, high importance)? **No direct role**

4.5.1. Outcome SN05a (Ashok, NEFORD, ASA, DRI)

**Outcome statement**

Local NGOs including Ashok Sansthan, Ghazipur, the Nand Educational Foundation for Rural Development (NEFORD), Action for Social Advancement (ASA) and Deendayal Research Institute (DRI) engaged in the pilot and regular field trials. They **hosted the KVKs and thus supported coordination and implementation of the pilot and regular field trials** and demonstrated superior seed varieties to the farmers. NGOs were not using the Climate Analogues / GIS software.

**Contribution statement**

Working closely with the local ICAR extension systems (KVKs), **Biodiversity India** helped to raise awareness in NGOs of the importance of broadening the genetic base of cultivated crops and trained them in producing quality seeds, long term seed storage. Between 2011 and 2015, Bioversity India organised farmers field days and 2 to 3 workshops per year, as well as at the Delhi office funded by Bioversity with participants from the NGOs that were partnering with the S4N project as well as other Indian scientists recommended by ICAR. Some participants had worked with CGIAR / Bioversity before, i.e. Dr R. K Singh from NEFORD. The workshops aimed to build capacity in how to use spatial data (CCAFS' Climate Analogues tool, GIS, DIVA-GIS, FloraMap, Maxent) as well as seed conservation/storage.

**Significance of outcome**

Increasing capacity in NGOs and helping them to support farmers to test and grow climate adapted varieties allowed Bioversity to establish partnerships that helped them involve farmers at a scale that would otherwise not have been possible.

During the project, the organisations supported the S4N program being funded partly from the CCAFS and partly from the ICAR grant. After the pilot trials, some voluntarily continued their support, but to a limited extend. These organizations started producing seeds of different varieties that were selected by the farmers during the Participatory Varietal Selection (PVS) trials and crowdsourcing trials (See SN06).

**Importance of contribution**

Capacity building was one of the main objectives in this project and working with the NGOs strengthened capacities and skills for identifying suitable genetic material for changing climate conditions. Also, by hosting the KVKs, the NGOs provided access to a variety of different sites, conditions and farming systems. For example, DRI is located at Chitrakoot, Madhya Pradesh and has two KVKs, one located in Madhya Pradesh and one in Uttar Pradesh about 47km apart, and both have different agro-climatic conditions and farming systems. This is important to get different perspectives from the ground.
4.5.2. Outcome SN05b (HPPI and Gene Campaign)

**Outcome statement**

Two further NGOs, [Humana People to People, India (HPPI)](https://www.humana.org) and [Gene Campaign](https://genecampaign.org) first worked with Bioversity for a separate project that was funded by the Treaty Secretariat, which had related objectives to the S4N work, and then joined the S4N collaboration when the crowdsourcing (CS) approach started, between 2012-2014.

**Contribution statement**

The programs with Gene Campaign and HPPI were funded by two different grants under ‘Access and Benefit Sharing’ II call from the ‘International Treaty on Plant Genetic Resources for Food and Agriculture’, and the proposals were developed in partnership with Bioversity. Bioversity also played a key role for the implementation of the project in terms of selection of varieties for the farmers’ field trials and providing guidelines for data gathering and data analysis.

**Significance of outcome**

See SN05a

**Importance of contribution**

See SN05a

4.6. Umbrella outcome 6: Farmers engage in pilot trials and later in PVS and CS trials; they are increasingly aware of the need for diverse good quality seeds, are willing to grow more varieties, establish networks to exchange seeds and test different varieties.

Importance of the Climate Analogues tool for the achievement of this outcome: engaging farmers in pilot and regular trials (no direct role, low, medium, high importance)? **No direct role**

4.6.1. Outcome SN06

**Outcome statement**

During the [pilot trials 2010/11](https://www.bioversityinternational.org), there were about 80 farmers involved who could increase their knowledge about new sources of seed material and started to grow a larger number of varieties on farm, as well as changed farming practices in order to increase yields (i.e. they started line-sowing instead of broadcasting seeds). The [regular trials started with 30 farmers testing wheat varieties in Vaishali, Bihar, in 2011/12](https://www.bioversityinternational.org) and expanded quickly to 800 farmers in the wheat trials in 2012/13. At the end of the trials the new approach was perceived positively by the farmers. [Farmers’ Organizations](https://www.bioversityinternational.org) including the Society for Conservation of Natural Resources and Empowering Rural Youth, Karnal, Haryana, India were also involved for undertaking field trials in Karnal, Haryana in the 2011/12 trials.

**Contribution statement**

To initiate farmer engagement, [Bioversity](https://www.bioversityinternational.org) collaborated with ICAR that had an extensive decentralised staff expertise and access to a huge network of farmers throughout India who trust the ICAR expertise. The local ICAR staff (KVKs) hence were in a much better position to talk to farmers than Bioversity India would have been at this point in time to identify farmers willing to participate in the initial trials. The farmers were positive about the pilot trials and motivated to continue in the subsequent regular trials.
The educational work of Bioversity, as well as the local ICAR extension services (KVKs) from ICAR offices, NGOs, and universities - promoting diversity instead of one of the same - showed farmers that planting different varieties of crops can lead to higher yields and minimize the risks in the light of climate change. This was best demonstrated by the on-farm trials themselves lead by Bioversity; in addition, Arnab Gupta from the Bioversity Delhi office provided training on seed collection and conservation to farmers and to NGO staff (see SN09).

Significance of outcome
The field trials led to a general change in attitude of the farmers understanding the need for growing different varieties and changing particular farming practices in order to increase yield and ensure agricultural productivity under a changing climate. Based on the outcome of the wheat and rice pilot projects, it was observed that most of the selected varieties outperformed those, which farmers were cultivating over the years and farmers were happy to continue to grow some of the selected varieties as per their choice. Hence the pilot and regular trials succeeded in establishing a growing farmers’ network, with participants willing to grow more seed varieties.

Importance of contribution
Climate Analogues did not play a direct role in this work

### 4.7. Umbrella outcome 7: Farmers become ‘citizen crop scientists’, providing feedback on their preferences, collected through innovative technologies (mobile data collection, iButton weather sensor)

Importance of the Climate Analogues tool for the achievement of this outcome: engaging farmers to become ‘citizen crop scientists’ (no direct role, low, medium, high importance)? No direct role

#### 4.7.1. Outcome SN07

**Outcome statement**
In 2012, the farmers started sharing information on crop performance through field staff using dedicated mobile devices and software developed by Bioversity. The information was sent to Bioversity Delhi office and compared with data from weather sensors in the farmers’ fields, known as iButtons that recorded the local weather conditions. India was the first country where these micro-weather recording devices were installed to compare how varieties perform under different micro-climate. The iButton records temperature and humidity at any given time interval; they are mounted on specially designed stands made of PVC pipes. The data are downloaded from the iButtons onto portable recorders from the fields. In 2012, Bioversity first started testing the iButtons during trials with 14-18 wheat varieties at three districts in Bihar. The weather data collected through the iButtons showed that, at the end of the season, some of the varieties had performed extremely well despite a dryer season than usual and thus were selected by the farmers for future planting. From then onward, data from the PVS trials was collected every year and analysed at Bioversity Delhi office by univariate general linear model (Using SPSS 20.0) and based on the results, next year PVS trials are planned. The iButtons are still in use today and data is collected from all c. 15’000 farmers participating in the network.

**Contribution statement**
In 2012, Prem Mathur initiated a process to get funding support from the Vodaphone Foundation and Sarika Mittra from Bioversity India engaged with Vodafone India to develop a mobile app to efficiently collect farmer feedback, but the project was stopped due to reasons internal to Vodafone. Paul Quek (Bioversity International) and Sarika Mittra then prepared a crowdsourcing data collec-
tion questionnaire using Open Data Kit (ODK). Since the regular inclusion of other crops, the new questionnaire is being prepared on a regular basis by Neeraj Sharma (Bioversity International) and uploaded by Paul Quek. The collected information is extracted at the Delhi office by Neeraj for further processing. Since 2014, Bioversity provided overall 30 tablets to various partner organisations in India and trained their staff (3 tablets with DRI Chitrakoot; 2 with KVK Majhgawa and 1 with KVK Ganiwa; 3 in Bihar and 5 tablets in Odhisa, ICAR-KVK; farmers did not obtain the apps/tablets); they are still in use today. Other NARES of ICAR and NGOs disseminated the tablets and apps to other sites. Bioversity also developed a data analysis software called ClimMob to help with the CS trial seed variety randomization for distribution to farmers and analyse the season’s data to identify trends and give farmers feedback based on the collected data. The results are shared by Bioversity’s partners during field days, seed diversity air and seed distribution programmes. To improve the visibility of the program, farmers’ fairs are being regularly organized where farmers of the network share their experiences and feedbacks at an open platform. These fairs help in reaching to those farmers also who are not the part of the trials. In April 2017, a farmers’ fair was organized at Vaishali (Bihar), where more than 1000 farmers participated from three districts of Bihar and interacted with each other.

**Significance of outcome**

The apps and tablets allowed the partner organisations to digitally (and thus more efficiently) collect and upload at near real-time quantitative and qualitative data on the characteristics of the harvest the seeds yielded staggered throughout the seasons. Collating this information showed that some varieties were actually performing better in areas for which they were not originally designed. Hence, the information served to further narrow down useful varieties and trends for specific locations.

Comparing the data with Information on the local weather from the iButtons provided a bigger picture of seasonal weather trends in the states where the programme was active and thus the iButtons helped to shape future government seed distribution. Involving the farmers directly as ‘citizen scientists’ in evaluating and selecting varieties i) provided valuable feedback on their preferred traits to scientists, and ii) increased their first-hand knowledge of useful varieties and traits.

**Importance of contribution**

Climate Analogues did not play a direct role in this work.

### 4.8. Umbrella outcome 8: National government decides to expand the S4N program involving further regions and seeds

**Importance of the Climate Analogues tool for the achievement of this outcome:** ICAR agreeing to expand S4N to more sites and further states, DDG/ICAR asking for follow-on proposal (no direct role, low, medium, high importance)? **Medium**

#### 4.8.1. Outcome SN08a (expansion to further sites, states, and inclusion of further crops)

**Outcome statement**

In 2013, Indian government through ICAR agreed to expand the S4N model to sites in further states of India: Chhattisgarh and Madhya Pradesh in addition to the existing locations in Bihar and Uttar Pradesh (Punjab, Haryana and Nepal were dropped after 2011); Odisha joined in 2014. By 2016, ICAR had incorporated the approach in a national program covering more than 600 villages of 49 districts of seven states in Eastern, Central and Northern part of India. Today, S4N is active in the states of Bihar, Uttar Pradesh, and Madhya Pradesh. S4N is no longer working in Punjab, Haryana, Chhattisgarh and Orissa states: like in Punjab and Haryana the farmers do not show interest in growing more varieties as they have large farms and undertake intensification agriculture.
In 2015, there were additional crops included in the trials, for example selected varieties of mustard, mungbean, sesame and chick pea seeds in Madhya Pradesh, where there are now higher temperatures until March and lower rainfall than previously. Especially mustard performed excellent and was liked by the farmers. In addition to these, crops vegetables were also promoted.

**Contribution statement**

Bioversity India’s engagement with the ICAR partner institutions and the success of the pilot and regular trials in 2011/2012 (see SN01a,b), convinced ICAR to agree to an expansion of the program. The regular field trials in Bihar and Uttar Pradesh had increased the farmers’ network from 30 to 800 in 2 years (2012-2013). The progress of all activities included in the five year ICAR-Bioversity work-plan was reviewed each year during a joint meeting of ICAR senior staff and al CGIAR centers present in Delhi, including Bioversity International. Accordingly, Bioversity presented also the S4N activities and outcomes for each year during such meetings and the plans for the next year were approved during this meeting. The CCAFS South Asia Office was in regular touch to develop the S4N plan and monitoring the outcomes.

Bioversity in consultation with ICAR senior management staff reviewed the programme on a yearly basis. Bioversity staff is in regular contact with the Regional Project Directors of KVKs and based on their suggestions Bioversity expanded the programme. During 2015, Bioversity organised a two day national consultation, where they invited all the Regional Project Directors of KVK and the head of selected KVKs to review the progress of the S4N project and planning for its expansion. Bioversity staff also participated in many of the Annual Workshops of these KVKs to raise the importance of this work.

**Significance of outcome**

The longer term commitment of government resources allowed to plan the scaling out of the test trials, involvement of more farmers and communities, planning for the Community Seed Bank implementations at various sites (see SN09), and testing of further crops. Expanding the S4N program to further Indian states meant a geographic spread of the knowledge and knowhow gained in the trials in 2011 and 2012 and a further increase in capacity built in local field staff (ICAR and NGOs). Also, the geographical catchment area for identifying germplasm varieties increased.

**Importance of contribution**

The good performance of the field trials using pre-selected seeds convinced the ICAR institutes to commit further resources. The Climate Analogues tool – as part of a toolbox - had a medium importance for the S4N approach, helping to identify crop traits and varieties that will be needed in particular locations, as well as locations where crop diversity will be at risk due to climate change so that endangered genetic resources can be collected and conserved. Today, the Climate Analogues tool is part of Bioversity’s Resilient Seed Systems methodology ([http://www.seedsresourcebox.org/](http://www.seedsresourcebox.org/)) and used in one of the eight steps involved (Step 3. Climate change analysis and identification of germplasm).

4.8.2. Outcome SN08b  (DDG/ICAR asks for follow-on project proposal)

**Outcome statement**

In 2016, the **Deputy Directors General (DDG, extension services) of the ICAR** requested Bioversity to submit a separate project proposal to further strengthen this work in India. This is currently under processing.
Contribution statement

The request was a result based on the significant outcomes of the S4N program conducted collaboratively by Bioversity, ICAR and the KVKs during 2011-2016.

Significance of outcome

With the continued commitment of ICAR the S4N program will be able to out-scale further. It is expected that, in future, the farmers network will increasingly grow automatically: farmers will share their knowledge and project outputs via their family connections; some will sell seeds from the S4N program in the market. Also, S4N seeds will become a regular part of the seed material of the KVKs and they will disseminate these not only to the farmers originally included in the S4N program, but throughout the districts they work in.

Importance of contribution

Climate Analogues did not play a direct role in this work.

4.9. Umbrella outcome 9: Farmers and communities engage with or set up Community Seed Banks; they share varieties within Seed Multiplication Groups, Self Help groups (‘Community Seed Savers Groups’) and conserve selected varieties

Importance of the Climate Analogues tool for the achievement of this outcome: farmers setting up CSBs, engaging in Seed Multiplication Groups and Community Seed Savers Groups (no direct role, low, medium, high importance)? No direct role

4.9.1. Outcome SN09

Outcome statement

In 2014, groups of farmers initiated the process of seed multiplication and setting up community seed banks (CSB) offering them informal ways of obtaining access to a variety of seeds as an alternative source for planting in the next season. One of the first CSBs was established in Raipur, Chhattisgarh, where part of the harvested seeds were saved from the farmers own crops and different varieties of seeds were exchanged among friends and neighbours. Also in 2014, a CSB was set up in Etah, Muzaffarpur, Bihar. In 2015, a CSB was setup in Imliyakoder (Balrampur district of Uttar Pradesh) to conserve the diversity of cereals, millets, pulses and other crops of the tribal areas at the foothills of the Siwalik hills. Ten more seed banks were established at the Chitrakoot region, Uttar Pradesh, which is known for its rain-fed and water scarcity ridden agriculture. Of these, seven seed banks are under the direct supervision of farmers’ communities and 3 seed banks are supervised by the Krishi Vigyan Kendra (Farm Science Centres) in the region. In total, the 14 CSBs, mainly set up across project sites, are currently storing together ~ 500 varieties of 21 crops, which includes the local varieties plus the seed of varieties we provided them for farmers field trials under seed for need programme. Not all of these seeds are currently also in the national genebank, but some accessions were also provided by respective KVKs (see SN02).

Contribution statement

Arnab Gupta from the Bioversity Delhi office supported this work visiting the communities and explaining to farmers that the market was not the only place to purchase seeds and how to establish local CSB as an additional source for planting material. The local extension systems supported the work (KVK Majhgawan, KVK Ganiwa and KVK Gopalgram) and the NGO DRI executed the work. Bioversity Researcher Arnab Gupta trained the NARES staff and farmers communities in Satna, Chitrakoot and Balrampur district how to store seeds and maintain a Community Seed Bank. Today,
Bioversity is only involved in monitoring the work. The farmers provided the space for setting up the seed banks and CCAFS contributed project funding for the furnishing, e.g. seed containers, bottles, drying beads for seed drying, shelves, some small seed testing equipment, seed graders, working tables and lighting facilities. 

**Significance of outcome**

Community-managed seed banks help to conserve traditional farmers’ varieties and maintain seed security at the district and community level. The project successfully engaged the farmers to request for more diversity for on-farm testing and contribute resources in order to set up local seed systems and community seed banks to maintain and distribute seeds of selected varieties to other networked farmers. Thus, rural communities in the IGP are better able to use adapted genetic materials through an improved local seed system network and agricultural systems are more resilient to climate change.

Further, Bioversity India aims to connect the local seedbanks to the national genebank in order to ensure long term storage of the local varieties. Transferring local varieties to the national genebank allows to further safeguard these resources and also to screen the accessions for climate suitability. This has yet to start, but, evaluations are currently ongoing to document the characteristics of varieties so that they can be shared with NBPGR.

**Importance of contribution**

Climate Analogues did not play a direct role in this work.

4.10. Umbrella outcome 10: Increasing numbers of stakeholders (ICAR, universities, NGOs, private sector) engage in capacity building to better implement policies enhancing the involvement of farmers and supporting their use of biodiversity.

Importance of the Climate Analogues tool for the achievement of this outcome: increasing numbers of national stakeholders participating in the S4N project (no direct role, low, medium, high importance)? **Medium**

4.10.1. Outcome SN10

**Outcome statement**

During 2-6 Dec 2013, 8 representatives of ICAR as well as one person from the 'Council of Scientific & Industrial Research' (CSIR, an industrial R&D organisation) and one person from the State Agricultural University became aware of and gained skills in employing the Climate Analogues software and GIS by taking part in a 5-day Regional Training Workshop on "GIS and Climate Analogue Tools for PGR Management and Enhanced Use" in New Delhi. All participants received training in the Climate Analogues tool, having the opportunity to listen to presentations by experts on selected topics (25% of the time) and to work hands-on (75% of the time). The partners are using these tools for their routine project works both within and outside CCAFS projects.

**Contribution statement**

The workshop was part of the NBPGR ex situ project (see SN02). **NBPGR** organized this workshop in collaboration with **Bioversity** at the NBPGR premises, New Delhi. The Indian participants were funded through the NBPGR project fund. Amongst other contributions, **Prem Mathur, Regional Director, Bioversity International**, highlighted the collaborative programmes taken up by Bioversity International and NBPGR in the field of identifying pre-adapted germplasm for climate change. **Sarika Mittra** was the principal resource person for the training programme of the workshop, together with Vasudeva Rao (Network coordinator of Agricultural Ornithology, Hyderabad) and RN Sahoo Agricultural Physics, IARI)
Significance of outcome

The goal of the workshop was to engage further stakeholders in India (and from abroad, see SN12) and enhance their capabilities to manage and utilize plant genetic resources (PGR) effectively in the face of climate change demands. Specifically, the objectives were to

- Impart contemporary knowledge on GIS, climate data, climate analogues and their applications in PGR management and utilization
- Provide hands-on experience on various software, databases, clustering and analysis
- Transfer knowledge on the analysis of actual data, interpretation and decision making in PGR management

Importance of contribution

The training in GIS and the Climate Analogues tool provided both a platform for capacity building in GIS techniques and the Climate Analogues tool, as well as for engagement and general knowledge exchange in PGR management.

4.11. Umbrella outcome 11: Farmers’ participation increases as they take up using sustainable yields and resilient farming system

Importance of the Climate Analogues tool for the achievement of this outcome: increasing farmer participation (no direct role, low, medium, high importance)? No direct role

4.11.1. Outcome SN11

Outcome statement

Farmers in India rapidly engaged in the S4N program taking up using sustainable yields and resilient farming systems: numbers increased from 30 participating farmers when starting in 2012, to 5000 in 2013/2014, and the network has grown to over 15'000 farmers involved at the present. Today, farmers at over 600 villages in three states are involved in the program (Bihar, Uttar Pradesh, Madhya Pradesh). All farmers received the seed packets for CS or PVS trials and data regarding performance or farmers’ preference has been collected. Hence, all have been exposed to new varieties and many of them agreed to save and share and save the seeds of new varieties (See Figure 1 for a study conducted in Bihar).

Contribution statement

The methodology used in this Biodiversity lead programme on participatory experimentation and crowdsourcing and the results described in the previous outcome descriptions facilitated a nationwide spread of the program’s implementation and a rapid involvement of large numbers of farmers in India.

Significance of outcome

Through the large increase in the number of participating farmers the S4N India program could i) tap even deeper into the genetic diversity of germplasm existing in different locations in India and ii) reach an even wider community and increase their effective access and use of plant genetic resources in the context of climate change adaptation.

Importance of contribution

Climate Analogues did not play a direct role in this work
Table 1: expansion of the seeds for needs program from 2012 to date

<table>
<thead>
<tr>
<th>Crop /season</th>
<th>States</th>
<th>Districts</th>
<th>No of farmers doing CS trials</th>
<th>Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat 2012-13</td>
<td>2</td>
<td>7</td>
<td>800</td>
<td>10</td>
</tr>
<tr>
<td>Rice 2013</td>
<td>2</td>
<td>5</td>
<td>1,200</td>
<td>22</td>
</tr>
<tr>
<td>Wheat 2013-14</td>
<td>2</td>
<td>7</td>
<td>5,000</td>
<td>20</td>
</tr>
<tr>
<td>Rice 2014</td>
<td>3</td>
<td>18</td>
<td>7,000</td>
<td>37</td>
</tr>
<tr>
<td>Wheat 2014-15</td>
<td>4</td>
<td>19</td>
<td>15,000</td>
<td>43</td>
</tr>
<tr>
<td>Rice 2015</td>
<td>5</td>
<td>25</td>
<td>3100</td>
<td>39</td>
</tr>
<tr>
<td>Wheat 2015-16</td>
<td>3</td>
<td>11</td>
<td>6300</td>
<td>30</td>
</tr>
<tr>
<td>Rice/Sesame/Pulses 2016</td>
<td>4</td>
<td>7</td>
<td>2745</td>
<td>Rice-15</td>
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<td></td>
<td>Veg-10</td>
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<td></td>
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<td></td>
<td>Sesame-2</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Pulses - 4</td>
</tr>
<tr>
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<td>3</td>
<td>7</td>
<td>4320</td>
<td>Wheat-13</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mustard-8</td>
</tr>
</tbody>
</table>

Figure 1: expansion of the seeds for needs program from 2012 till date

Acceptance of the CS trials in Bihar
A sustainability study in Vaishali and Samastipur district
4.13. Umbrella outcome 12: **Funders** commit to funding related projects based on proposals informed by results from the S4N program

Importance of the Climate Analogues tool for the achievement of this outcome: International stakeholders start participating in the S4N project (no direct role, low, medium, high importance)? **Medium**

4.13.1. Outcome SN12

**Outcome statement**

An anonymous funder, who had already funded the conceptual phase of the S4N program in 2010/11, funded further S4N projects in Laos and Cambodia (Seeds 4 Needs - Climate-smart agriculture for poor rural communities in Laos & Cambodia) from 2014-2017/03. Further, the Global Environment Facility (GEF) approved the implementation of a project entitled “Mainstreaming agricultural biodiversity conservation and utilization in agricultural sector to ensure ecosystem services and reduce vulnerability” related to S4N in India to be launched in 2017/05, and will support it with 3.5 M US$.

**Contribution statement**

Bioversity Delhi offices developed the proposals and engaged with donors.

**Significance of outcome**

The additional programs allow a further outscaling of the S4N project.

**Importance of contribution**

The proposals were developed drawing from the successes and learnings from the S4N program in India, which convinced the funders to commit resources. This included also the concept of increasing the diversity of high yielding seed varieties using GIS and Climate Analogues software.

4.14. Umbrella outcome 13: **International stakeholders** engage with CCAFS partners or participate in knowledge sharing and learning events.

Importance of the Climate Analogues tool for the achievement of this outcome: International stakeholders start participating in the S4N project (no direct role, low, medium, high importance)? **Medium**

4.14.1. Outcome SN13

**Outcome statement**

During 2-6 Dec 2013, four representatives from neighbouring countries of the South East Asia, two from Vietnam and one each from Laos and Cambodia, became aware of and gained skills in GIS and Climate Analogues software by taking part in a 5-day Regional Training Workshop on "GIS and Climate Analogue Tools for PGR Management and Enhanced Use" (see SN10). Today, national gene-bank staff of several Asian countries are using these tools including Nepal, Bhutan, Laos, Cambodia and Papua New Guinea.

**Contribution statement**

The workshop was organised and facilitated by NBPGR in collaboration with Bioversity (see SN09). The foreign participants were funded by Bioversity and CCAFS South Asia.
Significance of outcome
By engaging stakeholders from other Asian countries though this workshop it was hoped to extend the reach of the S4N program beyond the borders of India.

Importance of contribution
See SN10: The training in GIS and the Climate Analogues tool provided both a platform for capacity building in GIS techniques and the Climate Analogues tool, as well as for engagement and general knowledge exchange in PGR management.