



RESEARCH PROGRAM ON  
**Climate Change,  
Agriculture and  
Food Security**



**CIP**

**2013 technical report**

## 1. Activity Reporting

### Activity 513-2013 (Milestone 4.2.1 2013 (2).)

**Title:** Evaluating different downscaling methods and the uncertainty they contribute to agricultural impacts modelling

**Status: Incomplete.** The additional budget for this activity was not allocated and will be conducted in 2014

**Gender component:**

**Deliverables:**

- Journal article on the results of the evaluation, along with information that can accompany downscaled data available on the internet.

The funds originally allocated by CCAFS could not be disbursed. Deliverable changed for 2014 provided there are funds allocated.

- One output from this first workshop will be a compendium of different methods, along with known advantages and disadvantages, and a protocol for a harmonised approach to testing and applying these methods (via one or more crop models) over the subsequent months.

The funds originally allocated by CCAFS could not be disbursed. Deliverable changed for 2014 provided there are funds allocated.

**Partners:**

**Locations:**

Global

### Activity 589-2013 (Milestone 4.3.1 2013) Commissioned

**Title:** Development of new virtual crop parameters for assessment of potential investments to improve resilience to climate change for potato and sweet potato.

**Status: Partially complete.** During 2013, further work has been dedicated to the development of new virtual crop parameters for assessment of potential investments to improve resilience to climate change for potato and sweet potato production. In the first instance, a systematic analysis with virtual crop cultivars using the DSSAT-SUBSTOR potato model has been carried out with the objective of gaining further experience with the practice of virtual crop modeling and to illustrate the suitability of SUBSTOR for that purpose. Results have been presented at the AgSystems Seminar of the Agricultural and Biological Engineering Department of the University of Florida (UFL) [1] and at an international conference of agricultural research and development in Germany in September 2013 [2]. This work is currently extended to a journal article. Submission is expected for February 2014. To further strengthen the crop modeling work in the context of this activity, in 2013 a partnership with the



Agricultural & Biological Engineering Department of the UFL has been established. This partnership is aligned with the broader context of this activity, which is the Global Futures for Agriculture Project / Strategic Foresight work coordinated by IFPRI (see also Activity 589-2014). Within the scope of the partnership, which is supported by this activity takes place in collaboration with GIS modelers from IFPRI, a team of crop modelers at UFL is working to improve the global geospatial crop model simulations that are carried out for the Global Futures Project, thus allowing the project to generate better and more robust results. Specifically, the work done by UFL comprised the definition of mega-environments for potato production, the development of planting date and harvest rules for potatoes in the Global Futures project's GIS modeling framework and the development and validation of a global baseline simulation of potato production under current climate conditions. A report on the definition of mega-environments is currently under preparation [3] (draft supplied with this activity report) and is expected to be finished by February 2014. The simulation and validation of the global potato baseline is planned for late January 2014. Further, as part of the collaboration with UFL, a systematic comparison of priority traits targeted by potato breeders in developing countries with the genetic coefficients and other parameters of the SUBSTOR potato model has been carried out. The results of this exercise have been summarized in a report and published at the open access research portal zenodo.org [4]. It is planned to extend the partnership with UFL into 2014. The envisaged activities include develop simulation experiments with virtual potato cultivars, and the simulation of virtual potato cultivars under alternative climate change scenarios using the Global Futures project's geospatial crop modeling framework with the improved and validated baseline for potatoes. Further, it is planned to include work on sweetpotato crop modeling in the activity. In the wider scope of the Global Futures Project / Strategic Foresight work taking place under the umbrella of CRP PIM, a quantitative assessment of promising agricultural technologies is being carried out since in the second half of 2013. For this assessment, which employs the combined global crop modeling – economic modeling framework developed by the Global Futures Project, a set of virtual potato cultivars characterized by heat tolerance, drought tolerance and a combination of these has been developed and simulated for target regions in Asia. The virtual potato cultivars and additional descriptions of this technology are summarized in a “technology brief”, currently for internal use in the Global Futures Project [5]. Together with the results of the analysis, the content of this document will form part of a technical report which is directed to decision makers at international donor organizations, such as the Bill and Melinda Gates Foundation as well as within the CGIAR itself. The technology brief is supplied with this activity report. The final report to CGIAR is expected to be completed by the first quarter of 2014. In July 2013, a paper titled “Ex-ante Evaluation of Improved Potato Varieties for Sub-Saharan Africa” was presented to an audience of African potato scientists and representatives of governments and the private sector at the 9th Triennial Conference of the African Potato Association in Kenya [6]. The presentation highlighted to contribution of genetic improvements in potato to the economic welfare in the region and identified critical issues for the success of investments in potato breeding in the region, such as the development of seed systems. The paper is currently under revision with CABI for publication in an edited book “African potato and sweetpotato value chains: Transformations for food security and income”. In September 2013, a presentation “Global integrated bio-economic modeling - A toolkit for the assessment of priorities for international agricultural research” been given at the “FSC in dialog” seminar at the Food Security Center (FSC) of the University of Hohenheim, Germany [7]. The presentation dealt with the modeling and assessment approach developed in the Global Futures project and reached an audience of graduate and post-graduate

students as well as faculty members of the university. A final publication of 2013 is “Really a nontraded commodity? A look at the international potato trade network (dataset and R code)” [8]. The work for this publication was carried out in early 2012 for the Global Futures for Agricultural Project. Since the CIP activities at that time were also funded by CCAFS, the corresponding attribution is included in this publication. [1] Kleinwechter, U. (2013), “Potato crop modeling for technology impact assessment”. Presentation held at the AgSystems Seminar of the Agricultural and Biological Engineering Department, University of Florida, 24 January 2013. [2] Kleinwechter, U., S. Asseng, M. Gastelo, J. Ritchie and J. Nelson (2013), Virtual crop modeling for technology impact assessment - lessons from a potato crop growth model. In: Tielkes, E. (ed.), Agricultural development within the rural urban continuum: book of abstracts; [Sept. 17 - 19, 2013, University of Hohenheim] / Tropentag 2013, International Research on Food Security, Natural Resource Management and Rural Development, p. 367. [3] Raymundo, R., U. Kleinwechter, R. Robertson and S. Asseng (2013), Global mega environments and cultivar parameters for potatoes. Draft report. [4] Raymundo, R., Kleinwechter, U., Asseng, S., 2014. Virtual potato crop modeling: A comparison of genetic coefficients of the DSSAT-SUBSTOR potato model with breeding goals for developing countries. ZENODO. <http://dx.doi.org/10.5281/zenodo.7687> [5] Kleinwechter, U. (2013), Crop Technology Technical Brief – Heat and drought tolerant potatoes for Asia. Global Futures for Agriculture Project technical document. [6] Kleinwechter, U., G. Hareau, M. Bonierbale, M. Gastelo, and D. Harahagazwe (2013), Ex-ante evaluation of improved potato varieties for Sub-Saharan Africa. Paper presented at the 9th Triennial Conference of the African Potato Association, 30 June – 4 July 2013, Naivasha, Kenya. Currently under revision for publication in an edited volume “African potato and sweetpotato value chains: Transformations for food security and income”, CABI. [7] Kleinwechter, U. (2013), Global integrated bio-economic modeling - A toolkit for the assessment of priorities for international agricultural research. Presentation at the FSC in dialog seminar, Food Security Center, University of Hohenheim, Germany, 16 September 2013. [http://fsc.uni-hohenheim.de/fileadmin/einrichtungen/fsc/FSC\\_in\\_Dialog/previous\\_FSC\\_in\\_dialog/2013/FSC-in-dialog-16-Sep-2013.pdf](http://fsc.uni-hohenheim.de/fileadmin/einrichtungen/fsc/FSC_in_Dialog/previous_FSC_in_dialog/2013/FSC-in-dialog-16-Sep-2013.pdf) [8] Kleinwechter, Ulrich and Suarez, Victor. (2013). Really a nontraded commodity? A look at the international potato trade network (dataset and R code). ZENODO. doi:10.5281/zenodo.7593

### Gender component:

At the current point there is now explicit gender integration for this activity. For the technology assessment activities of the Global Futures and Strategic Foresight project as a whole, however, gender issues can be addressed via the selection of the promising new technologies to be evaluated with the modeling framework applied by the project. Due to their specific adoption potential and other factors some technologies, for example, can be considered to address distribution of benefits to women agricultural producers better. The methodological approach taken by the Global Futures activity allows for comparisons of these technologies with technologies which do not have this specific gender dimension or which tend to favor male producers.

### Deliverables:

- Report on new virtual potato cultivars developed. Paper submitted for inclusion in a journal special issue. An early version of the paper expected for this deliverable has been presented as a conference paper in Kleinwechter, U., S. Asseng, M. Gastelo, J. Ritchie and J. Nelson (2013), Virtual crop modeling for technology impact assessment - lessons from a potato crop growth model. In: Tielkes, E. (ed.), Agricultural development within the rural urban continuum: book of abstracts; [Sept. 17 - 19, 2013, University of Hohenheim] / Tropentag

2013, International Research on Food Security, Natural Resource Management and Rural Development, p. 367. The article for submission in a journal is currently under preparation and is expected to be completed and submitted by February 2014.

**Partners:**

IFPRI; UF

**Locations:**

Global

**Activity 666-2013 (Milestone 1.2.1 2013 (2).)**

**Title:** User-friendly multiplatform (including open source) geospatial generic crop model (first cases potato and sweet potato) to model CC-crop responses scenarios using input from different regional and global climate and downscaling models.

**Status: Partially complete.** Both potato and sweet potato models are functioning and available in the Internet (link to download the software provided). The parameter calculator was built in the potato model as a test case and validated with Professionals from 15 countries in Africa and Latin America. It is worth highlighting that the calculator provides a tool for participatory modeling, where any person with knowledge about the phenology of the crop could interact and use to better understand the interaction between the crop and the environment (genotype, management, environment). Although we have tested it with professionals we are sure the tool will work with non-professionals as well and will validate this hypothesis. Parameters for both crops are included as part of the report. A geospatial version of both potato models is up and running (Only potential conditions but working on a good geospatial model to accurately estimate potential evapo-transpiration). A new feature was added this year, the capacity to simulate across scales using scaling laws to account for spatial heterogeneity. CIP and USDA are co-leading the AgMIP Potato project. Short presentations are included as part of this report. WRF data for South America were generated by UCSB. Results are being validated to make them available. The SPDSM generates quite a lot of high resolution rainfall data. We need to agree on how we can make the data available in a CCAFS server or to have the model ready to run the downscaling for specific area where high resolution (1 Km) daily data is needed for modeling. The reason why we rate the status as partially complete is because the paper describing the use of the parameter calculator implemented in the potato model to optimize the value of historical breeding trial has not been submitted yet. All the participants in the African workshops are co-authors (over 30 co-authors) and thus it is taking longer than a regular paper but it is worth it.

**Gender component:**

**Deliverables:**

- Key crop growth parameters needed to model potato, sweet potato and Beans (with CIAT) derived from AgTrials data.

Potato and sweet potato submitted with the present report (Uploaded to CCAFS intranet)

- Scientific paper on Optimizing the value of historical breeding trials to model adaptability of root and tuber crops to variable climatic conditions.

We decided to produce a paper with all the participants in the yield-gap participatory modeling workshop where professionals from different countries in Africa used the parameters'calculator to add value to their breeding trial. A paper on modeling the impact of frost on potato was published: Condori B, Hijmans RJ, Ledent JF, Quiroz R (2014) Managing Potato Biodiversity to Cope with Frost Risk in the High Andes: A Modeling Perspective. PLoS ONE 9(1): e81510. doi:10.1371/journal.pone.0081510

- Intelligent system (final version) of the parameter estimator: potato, sweet potato and beans.

The Solanum model (C++) containing the parameter estimator can be downloaded. We are also including a Package in R (EASI) that contains the working version in R among other programs developed by the group

- Protocol and intelligent software for breeders to estimate canopy cover with a conventional digital camera to facilitate more accurate field data acquisition.

A beta version is available. New segmentations algorithms will be added in 2014.

- Wavelet-based multifractal temporal weather generator and geospatial SPDSM downscaled data.

A mechanism for placing the generated data for the public through CCAFS portals is pending

- Results from the AgMIP potato comparative analyses communicated.

1. Slide Share: Potato Pilot Progress: AgMIP Crop Model Intercomparisons & Improvement 2. Slide Share: Actividades de investigación en el Perú relacionadas al AgMIP y al impacto del cambio Climático 3. Poster: Fourth Annual AgMIP Global Workshop. AgMIP Potato Pilot: A summary of progress made 4. Draft Paper: Effect of different irrigation regimes on yield, water use efficiency and quality of potato (*Solanum tuberosum* L.) in the lowlands of Tashkent, Uzbekistan: a field and modeling perspective 5. Slide share: Information Technology applied to crop and livestock Production systems 6. Slide share: Avances en el Proyecto Ag-MIP

- Defined algorithms for an improved generic potato model based on modeling gaps detected with AgMIP comparative assessment.

for 2014

for 2014

#### Partners:

ALTAGRO; CIAT; USDA; UF

#### Locations:

Global

### Activity 667-2013 (Milestone 2.3.1 2014.)

**Title:** Expert System based on biological modeling and ancestral climate perception etnometeorological indicators developed and tested.

**Status: Partially complete.** Technical Report: Conceptualization of an expert system for the agricultural decision making, based on bio-indicators used for climatic predictions Workshop in Bolivia (La Paz) on: Documentation of this traditional knowledge, verification of bio indicators by communities, identify gaps, weaknesses and inconsistencies of these traditional knowledge "Uncertainty" and validity and dynamics of biomarkers. Technical Report: Based on the review of 24 papers on "lessons learned in the development of an etnoclimatic system

information based on bio indicators and local knowledge”. 5 cases of study: Bolivia, Peru (Piura, Altiplano), Colombia, Senegal.

### **Gender component:**

By participatory assessment of gender-oriented perceptions of climate change and climate risks.

### **Deliverables:**

- A prototype expert system summarizing farmers' perception of climate risk.

1. Technical Report: Conceptualization of an expert system for the agricultural decision making, based on bio-indicators used for climatic predictions

- Integration of local knowledge (expert system) to scientific knowledge (crop model).

Workshop in Bolivia (La Paz) on: Documentation of this traditional knowledge, verification of bio indicators by communities, identify gaps, weaknesses and inconsistencies of these traditional knowledge "Uncertainty" and validity and dynamics of biomarkers.

- Review and conceptualization of existing case studies on local communication networks and mental models.

Considering the issue of forecasts and local climate knowledge coupled with crop modeling tools, pests and diseases for support in decision making y that the activity leader holds a joint position between CIAT and CIP, and participated in the south-south learning Exchange in Senegal during 2013. The following activities are linked:

1. Technical Report: Under the participatory research approach, this activity represents a tool for climate risk management in agricultural production systems. Based on the review of 24 papers presented this technical report on “lessons learned in the development of an etnoclimatic system information based on bio indicators and local knowledge” which are used in farming communities where, will try to advance in verifying the assumptions of farmers and the degree of uncertainty in their climate predictions, the use of technology, social strategy and use of forecasts, as acts of resilience to be less vulnerable in their agricultural production.

2. Technical Report: 19 farmers participated in a workshop within the project between MADR and CIAT; on issues such as agro climatic information, in order to begin implementing “Climate Field Schools (CFSs)” participatory with farmers,. forming groups in which socialized among them a series of questions, as: ¿ Do you consider the local or traditional knowledge of climate behavior is enough to make decisions on your crop? And what skills or tools would help?

### **Partners:**

University of Missouri; CIAT; Universidad Nacional Agraria La Molina; SENAMHI

### **Locations:**

Latin America (LAM)



## Activity 668-2013 (Milestone 2.3.1 2013.)

**Title:** Modeling climate-sensitive pest and diseases in potato systems and their impact on yield

**Status: Complete.** Several papers and manuals included in the report

**Gender component:**

**Deliverables:**

- Expert system to assess impact of key pests and diseases on crop yield.

Delayed due to the lost of the postdoc financed by a bilateral program and the consultant hired is taking longer than anticipated

- Proof of concept of joint improved T and HR sub models improve overall accuracy and robusticity of model.

The leaf sensors available in the market proved inefficient for the task. Funds used for developing a routing for a LB model amenable to simulate the impact of climate on the progress of the disease when fungicides are used by small farmers, which is the common practice (see next deliverable.

- Improved leaf temperature and relative humidity models for simulating potato late blight in the tropics.

Due to the lack of suitable leaf sensors for late blight applications, CIP worked on the modeling of fungicide control under small farmers conditions. A progress report is included

- ILCYM Version 3.0 User Guide Manual.

Tonnang, E.Z.H., Juarez, H., Carhuapoma, P., Gonzales, J.C., Mendoza, D., Sporleder, M., Simon, R., Kroschel, J. 2013. ILCYM - Insect Life Cycle Modeling. A software package for developing temperature-based insect phenology models with applications for local, regional and global analysis of insect population and mapping, International Potato Center, Lima, Peru. pp 191.

- Farmers' awareness of climate change and coping strategies to control pests in sweetpotato in Uganda and maize in Kenya assessed (two reports).

Okonya J., J. Kroschel (2013): Incidence, abundance and damage by the sweet potato butterfly (*Acraea acerata* Hew. and the African sweet potato weevils (*Cylas* spp.) across an altitude gradient in Kabale district, Uganda. International Journal of AgriScience 3(11): 814-824.

Okonya J., J. Kroschel (2013): Indigenous knowledge of seasonal weather forecasting: A case study in six regions of Uganda. Agricultural Sciences 4 (12): 641-648.

Okonya, J. S., K. Syndikus & J. Kroschel (2013): Farmers' Perception of and Coping Strategies to Climate Change: Evidence From Six Agro-Ecological Zones of Uganda. Journal of Agricultural Science 5 (8): 252-263.

Okonya, J. S., K. Syndikus & J. Kroschel (2013): Understanding farmers' knowledge and coping strategies to control insect pests of sweetpotato under a changing climate in Uganda. International Potato Center (CIP), Lima, Peru.

- Insect Life Cycle Modeling (ILCYM) software – a new tool for regional and global Insect risk assessment under current and future climate change scenarios.

Sporleder, M., H.E.Z. Tonnang, P. Carhuapoma, J. C. Gonzales, H. Juarez & J. Kroschel (2013): Insect Life Cycle Modeling (ILCYM) software – a new tool for Regional and Global Insect Pest Risk Assessments under Current and Future Climate Change Scenarios. CABI Book publication, 412-427.

- Stakeholder consultation workshop to discuss potential pest risks and develop adaptation strategies

A workshop was planned to be conducted in Nairobi, Kenya. Unfortunately, for security reasons it had to be cancelled.



**Partners:**

ICIPE; UniValle

**Locations:**

Global

**Activity 669-2013 (Milestone 4.2.1 2013 (2).)**

**Title:** Statistical-Physics Downscaling model (SPDSM) to CCAFS regions (inputs from RCMs) and comparative assessment with other downscaling tools at regional and local scales.

**Status: Complete.** A multifractal downscaling model was conceptualized, programmed and tested in the Andes. Two input data were tried, TRMM and WRF. A paper describing the concepts with an application in a approximately 200km x 200 km in an area with heterogeneous terrain (800-6500 m.a.s.l.) and rainfall (annual average ranging from 250 - 5000 mm) was submitted to a scientific journal. Rainfall estimated by TRMM was downscaled to approximately 1 km with good results. The program is available and the data generated is also available.

**Gender component:**

There is a mistake here, there is no gender work in this activity.

**Deliverables:**

- SPDSM\_beta-1 version with input from UCSB-WRF regional model data running in CCAFS-CIP server. Beta-1 version ready to be downloaded.
  - Papers describing SPDSM\_beta 1 version submitted. Paper submitted in November 2013 to Nonlinear Processes in Geophysics. Abstract accepted in AGU 2013 with a WRF application
  - Training materials and courses for professionals in CCAFS regions: SPDSM and links with crop and hydrology models.
- For 2014
- Final version of the SPDSM available in CCAFS server.
- For 2015
- Downscaled data available at CCAFS sites as produced, since 2013 must agree on how to share data with CCAFS
  - Starting by the end of 2012, CIP-CPAD & CCAFS: blogs, facebook, twitter, youtube and newsletters.
- We need to enhance this aspect of the research

**Partners:**

UCSB; CIAT

**Locations:**

South East Asia (SEA)

## **Activity 670-2013 (Milestone 4.2.1 2013 (3).)**

**Title:** Modeling yield distribution as a function of climate variability and change, topography, and proxies for soil fertility in at least two CCAFS regions using joint multifractal distributions.

**Status: Partially complete.** Accurate modeling spatial yield predictions must deal with the uncertainty associated to the spatial variability; which can now be quantified and characterized with tools developed over the last decades. The current research proposes a methodology to estimate the bias introduced by ignoring yield reduction explained by spatial variability. Non-linear theories and remote sensing data from the Andes were used to classify and make a weighting matrix of areas with similar productivity. Weights were assigned to the results of a geospatial potato potential productivity model. The results show that conventional modeling techniques, when spatial variability is not considered, severely overestimate suitable planting areas as well as production. The magnitudes are at least comparable to the expected changes associated to projected climate change. The proposed methodology seems to be a suitable approximation to account for spatial variability in crop modeling, a method that can be applied at different spatial scales. The joint multifractal software is part of the cadre of software being produced by the team in R programming language and downloadable from our web site. A paper on the theory and application of joint multifractal is being prepared. The delay has been in the field data at different spatial scales that has taken longer than anticipated.

### **Gender component:**

#### **Deliverables:**

- Two (2) Papers submitted, reports, scientific meetings.

M. Carbajal, A. Posadas,, and R. Quiroz. Scaling in crop modeling: a proposed methodology to assess the bias introduced by spatial variability. Elsevier Editorial System(tm) for Environmental Modelling & Software Manuscript Draft The paper describing the theory and application of joint multifractal analysis is in preparation and will be submitted soon

- JMASS-beta version with pest analysis (Programmed in R).

The R Package EASI is included in the report

- Training on JMASS techniques and scaling approach.

Next reporting year

- Output data from different sites and scenarios available and incorporated into CCAFS support for decision-making in target areas.

Next report

- CIP-CPAD: blogs, facebook, twitter, youtube and newsletters, starting in 2012.

Next report

### **Partners:**

CIAT; UCSB

### **Locations:**

Latin America (LAM), East Africa (EA)

## 2. Succinct summary of activities and deliverables by Output level

### Output: 1.2.1

#### Summary:

A review paper summarizing the state of the art knowledge on drought tolerance and water use efficiency by the potato crop was published. We also made significant advances this year in the estimation of crop growth parameters for potato and sweet potato. A data base containing parameters for both crops are available. Every season we will be enhancing the data base with the new experiments. Notwithstanding, the existing database contains most potato species and hybrids as well as promising drought and heat tolerant clones developed by CIP. Sweet potato has a more reduced number but we are processing a few more that will be loaded in the upcoming weeks.

In the present reporting period we tested the new tool for estimating crop growth parameters. We conducted several participatory modeling workshops, co-financed by Humidtropics and RTB, in Africa and Latin America. Participants interact with the parameters calculator to estimate the growth and development parameters based on historical trials. The data base also includes the parameters estimated with this participatory methods once calibrated with yields obtained in the field.

Downscaled data together with a new approach for geospatial crop growth models (methods reported in output 4.2.1.) are also available (site to download them included in CCAFS intranet). A new protocol to assess spatial heterogeneity was tested with potato in the Andes and sweetpotato in Africa. In both cases the bias introduced by not accounting for spatial variability was large and must be accounted for.

### Output: 2.3.1

#### Summary:

Several papers and reports were produced on modeling pest and diseases in the potato crop and how climate change is likely to affect productivity. A metamodel framework to develop reduced form ecological models which retain the features of the original models was developed and validated for Late Blight (LB). An online tool for spatial LB mapping was also produced. Experiments were carried out to incorporate the use of fungicides by small farmers to control LB. The Insect Life Cycle Modeling (ILCYM) software for regional and global insect risk assessment was completed and promoted in several regions. The the version 3.0 of the user manual was published.

Participatory workshops where local forecasting experts and meteorologists from the national meteorology service were organized. The results were used to integrate knowledge using heuristic algorithms. A prototype expert system was conceptualized and is being programmed to be validated as a tool to reduce the erosion of the use of indicators. Another aspect of this research bringing local climate experts and scientists is to bridge the gap in communication to improve the flow of information to end users. Farmers perceptions of and coping strategies to climate change were evidenced in Uganda, as well as and Indigenous knowledge on seasonal

weather forecasting. A draft paper analyzing gender roles in Andean traditional societies and recent changes is also included in the report

**Output: 4.2.1**

**Summary:**

The presence of a monsoonal type of circulation - involving intensive convective activity and heavy precipitation is the dominant climatic feature in South America. Recent climate change in the South American Monsoon System (SAMS), where CIP partner UCSB developed and tested innovative methodologies and procedures to address the following questions: 1) Are there significant trends in the large-scale characteristics of the SAMS? 2) Do CMIP5 climate models realistically simulate the observed characteristics of the SAMS? 3) Do CMIP5 models project significant changes in the large-scale characteristics of the SAMS during the twenty-first century? The results were documented in 6 publications (included in the report); five published and 1 under revision.

The beta-1 version of the Statistical Physics Downscaling Model (SPDSM) was concluded and tested in the high Andes. The program was tested in a study area in the Andes of approximately 200 km x 200 km with altitude ranging from 800 to 6500 m.a.s.l and annual rainfall from 250 - 5000 mm. The consistency of the high resolution downscaled data indicates that the technique is an improvement over conventional statistical techniques. A paper describing the methodology and the application is under revision in a scientific journal and the program is downloadable from the link provided in the report.

To assess climate change impacts on agricultural systems and their supporting natural resources demand for robust methods to account for the bias introduced by spatial variability. A methodology based on scaling laws and (joint) multifractal theory was developed and tested through modeling potato in heterogeneous terrains in the Andes. It was shown that conventional crop modeling techniques, when spatial variability is not considered might produce severe biases in yield estimates. The paper describing the methodology is under revision in a peer-review journal.

**Output: 4.3.1**

**Summary:**

During 2013, the work towards the impact assessment at global and regional levels on agricultural systems has been continued in the scope of Activity 589-2013. Efforts have been dedicated to the development of new virtual crop parameters for assessment of potential investments to improve resilience to climate change for potato and sweet potato production. A systematic analysis with virtual potato crop cultivars has been carried out, resulting in a seminar at the partner University of Florida (UFL), a conference contribution and a journal article under preparation.

A partnership with the Agricultural & Biological Engineering Department of the UFL has been established in alignment with Global Futures for Agriculture Project / Strategic Foresight work coordinated by IFPRI, which provides the linkage between the socio-economic and crop model based analysis. The collaboration so far dealt with the improvement of global geospatial potato virtual crop model simulations. A report with the global



datasets required for the simulations (definition of mega-environments, inter alia) is currently under preparation and a report on virtual potato crop modeling has been published.

In the wider scope of the Global Futures for Agriculture Project / Strategic Foresight of CRP PIM, a quantitative assessment of promising agricultural technologies is being carried out and a technical report which is directed to decision makers at international donor organizations and the CGIAR is being prepared.

Further outputs from 2013 include a conference paper on the “Ex-ante Evaluation of Improved Potato Varieties for Sub-Saharan Africa”, which is currently under review for inclusion into and edited CABI book, a seminar presentation “Global integrated bio-economic modeling - A toolkit for the assessment of priorities for international agricultural research” at the Food Security Center (FSC) of the University of Hohenheim, Germany, and a dataset and program code for the analysis of international potato trade as part of a background study for global potato modeling.

### 3. Publications

#### Publication #1

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Bruno Condori, Robert J. Hijmans, Jean Francois Ledent, Roberto Quiroz. 2014. Managing Potato Biodiversity to Cope with Frost Risk in the High Andes: A Modeling Perspective. PLOS ONE. Volume 9, Issue 1: e81510

#### Publication #2

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Philippe Monneveux, David Ramirez, Maria Teresa Pino. 2013. Drought tolerance in potato (S.Tuberosum L) Can we learn from drought tolerance research in cereals? Plant Science 205-206: 76-86

#### Publication #3

**Type:** Journal papers

**CCAFS Themes:** Theme 2

**Citation:** Joshua S. Okonya and Jürgen Kroschel. 2013. Incidence, abundance and damage by the sweet potato butterfly (*Acraea acerata* Hew. and the African sweet potato weevils (*Cylas* spp.) across an altitude gradient in Kabale district, Uganda. Journal of AgriScience Vol. 3 (11) : 814-824

#### Publication #4

**Type:** Journal papers

**CCAFS Themes:** Theme 2

**Citation:** Joshua S. Okonya and Jürgen Kroschel. 2013. Indigenous knowledge of seasonal weather forecasting: A case study in six regions of Uganda. Agricultural Sciences. Vol.4, No.12, 641-648.

#### Publication #5

**Type:** Journal papers

**CCAFS Themes:** Theme 2





**Citation:** Joshua S. Okonya, Katja Syndikus & Jürgen Kroschel. 2013. Farmers' Perception of and Coping Strategies to Climate Change: Evidence From Six Agro-Ecological Zones of Uganda. *Journal of Agricultural Science*; Vol. 5, No. 8.

## Publication #6

**Type:** Book chapters

**CCAFS Themes:** Theme 2

**Citation:** Marc Sporleder, Henri E.Z. Tonnang, Pablo Carhuapoma, Juan C. Gonzales, Henry Juarez and Jürgen Kroschel. 2013. Insect Life Cycle Modelling (ILCYM) Software – A New Tool for Regional and Global Insect Pest Risk Assessments under Current and Future Climate Change Scenarios: in (ed. J. Peña) *Potential Invasive Pests of Agricultural Crops*. CAB International. Chapter 23, pp 412-427

## Publication #7

**Type:** Journal papers

**CCAFS Themes:** Theme 4.2

**Citation:** Rodrigo J. Bombardi, Leila M. V. Carvalho, Charles Jones, Michelle S. Reboita. (2013) Precipitation over eastern South America and the South Atlantic Sea surface temperature during neutral ENSO periods. *Climate Dynamics*. Online publication date: 15-Jun-2013.

## Publication #8

**Type:** Journal papers

**CCAFS Themes:** Theme 4.2

**Citation:** Rodrigo J. Bombardi, Leila M. V. Carvalho, Charles Jones. (2013) Simulating the influence of the South Atlantic dipole on the South Atlantic convergence zone during neutral ENSO. *Theoretical and Applied Climatology*. Online publication date: 15-Dec-2013.

## Publication #9

**Type:** Journal papers

**CCAFS Themes:** Theme 4.2

**Citation:** Leila M. V. Carvalho, Charles Jones. (2013) CMIP5 Simulations of Low-Level Tropospheric Temperature and Moisture over the Tropical Americas. *Journal of Climate* 26:17, 6257-6286. Online publication date: 1-Sep-2013.

## Publication #10

**Type:** Journal papers

**CCAFS Themes:** Theme 4.2

**Citation:** Charles Jones, Leila M. V. Carvalho. (2013) Multiannual-to-decadal variability of the American monsoons: present climate and CMIP5 projections. U.S. CLIVAR VARIATIONS

### Publication #11

**Type:** Journal papers

**CCAFS Themes:** Theme 4.2

**Citation:** Jones, Charles, Leila M. V. Carvalho, 2013: Climate change in the south american monsoon system: present climate and cmip5 projections. J. Climate, 26, 6660–6678. doi: <http://dx.doi.org/10.1175/JCLI-D-12-00412.1>

### Publication #12

**Type:** Working papers

**CCAFS Themes:** Theme 4.3

**Citation:** Raymundo R, Kleinwechter U and Asseng S. 2014. Virtual potato crop modeling: A comparison of genetic coefficients of the DSSAT-SUBSTOR potato model with breeding goals for developing countries. ZENODO. (Available from <https://zenodo.org/record/7687?ln=en>)

### Publication #13

**Type:** Conference proceedings

**CCAFS Themes:** Theme 4.3

**Citation:** Kleinwechter U, Asseng S, Gastelo M, Ritchie J and Nelson J. 2013. Virtual crop modeling for technology impact assessment - lessons from a potato crop growth model. In: Tielkes E, ed. Agricultural development within the rural urban continuum: book of abstracts. Tropentag 2013, International Research on Food Security, Natural Resource Management and Rural Development, University of Hohenheim, 17-19 September 2013. p. 367.

### Publication #14

**Type:** Conference proceedings

**CCAFS Themes:** Theme 4.3

**Citation:** Kleinwechter U. 2013. Global integrated bio-economic modeling - A toolkit for the assessment of priorities for international agricultural research. Presentation at the FSC in Dialog seminar, Food Security Center, University of Hohenheim, Germany, 16 September 2013.



## Publication #15

**Type:** Conference proceedings

**CCAFS Themes:** Theme 4.3

**Citation:** Kleinwechter U, Hareau G, Bonierbale M, Gastelo M and Harahagazwe D. 2013. Ex-ante evaluation of improved potato varieties for Sub-Saharan Africa. Paper presented at the 9th Triennial Conference of the African Potato Association, 30 June – 4 July 2013, Naivasha, Kenya.

## Publication #16

**Type:** Other

**CCAFS Themes:** Theme 4.3

**Citation:** Kleinwechter U and Suarez V. 2013. Really a nontraded commodity? A look at the international potato trade network (dataset and R code). ZENODO

## 4. Communications

### Media campaigns:

N/A

### Blogs:

Several blogs were (or are in the process of) posted in CIP and CCAFS web page

### Websites:

[cipotato.org](http://cipotato.org)

### Social media campaigns:

N/A

### Newsletters:

U.S. CLIVAR VARIATIONS Spring 2013, Vol. 11, No. 1

### Events:

CSA-Global Science Conference, UC Davis March 20-22

AgMIP conferences, Peru (Sept 19&20), Brazil (Sept 24-26) & New York (October 28-30)

Modeling workshop on potato yield gap analysis in africa (Nairobi, June 24-26)

Second Workshop on modeling yield gap in Africa (Addis Ababa (October 14-18)

Modeling Workshop on Potato yield gap in Latin America (Lima 25-29 October)

CCAFS acknowledge in all the events listed above

### Videos and other multimedia:

N/A

### Other communications and outreach:

Slides presented in the events listed above are posted on slide share. Link provided in the files uploaded to CCAFS Intranet

ILCYM USer Manual Version 3.0

Online/Offline tool for spatial mapping of Late Blight severity under different CC scenarios

Papers, reports and conferences

## 5. Case studies

### Case Study #1

**Title:** Climate Change in the South American Monsoon System: Present Climate and CMIP5 Projections

**Author:** Charles Jones and Leila M. V. Carvalho

**Type:** Breakthrough science

#### Project description:

The presence of a monsoonal type of circulation involving intense convective activity and heavy precipitation is the dominant climatic feature in South America. The South American Monsoon System (SAMS) is essentially driven by the differential heating between the continent and ocean. Observational and theoretical evidence points to the undeniable fact that Earth's climate is warming rapidly and anthropogenic activities play a vital role in the increases concentration of carbon dioxide. Warming over continents modify the distribution of the atmospheric heating altering ocean-continent contrasts with consequences to the monsoon circulation and hydrological cycle. In preparation for the 5th assessment of the Intergovernmental Panel on Climate Change (IPCC), the 5th phase of the Coupled Model Intercomparison Project (CMIP5) has coordinated a large set of climate model experiments to evaluate model performance and assess the confidence in multimodel climate projections

#### Introduction / objectives:

The CCAFS funding played an important role to further understand the impacts of climate change in the Americas. The case study investigated recent climate changes in SAMS, which is the most important climatic feature in South America. SAMS provides energy and water resources for millions of people. The typical onset of rains associated with SAMS occurs in mid to late October and the withdrawal in mid-April. Motivated by the availability of CMIP5 model simulations, this study documented changes in the SAMS (Jones and Carvalho 2013). The research specifically focused on the large-scale characteristics of the SAMS: seasonal intensity, onset and withdrawal dates, and duration. The following questions were investigated: 1) Are there significant trends in the large-scale characteristics of the SAMS? 2) Do CMIP5 climate models realistically simulate the observed characteristics of the SAMS? 3) Do CMIP5 models project significant changes in the large-scale characteristics of the SAMS during the twenty-first century? Innovative methodology and procedures were developed to investigate these questions.

#### Project results:

The climatological onset of SAMS occurs in mid to late October, whereas the withdrawal happens in late April. Our study examined the large-scale characteristics of the SAMS seasonal intensity, onset and withdrawal dates, duration and total seasonal precipitation (from the onset to the withdrawal). Changes in the SAMS were

investigated with precipitation, atmospheric data and CMIP5 climate model simulations for two scenarios: current (historic) climate and “worst case” scenario of climate projections (RCP8.5). Quantitative comparisons indicated that some CMIP5 models have significantly improved their representation of the SAMS, although some models still exhibit persistent deficiencies in simulating the SAMS. CMIP5 model simulations for the current climate experiment show signals of climate change in South America. The results show trends in the intensity, onset and withdrawal dates of SAMS. In recent decades, the monsoon has exhibited a more vigorous intensity and early onsets and late withdrawals. CMIP5 climate model projections for the 2010-2100 period indicate additional changes in some of the characteristics of SAMS. CMIP simulations of the historical experiment also indicate changes in the onset dates of the monsoon. All 10 models show negative linear trends indicating that the onset of the SAMS in recent years occurs earlier than in previous years, although the magnitudes of the trends vary among the models. Six out of the 10 models show statistically significant trends of earlier onsets. On the other hand, all 10 CMIP5 model simulations of the historical experiment show increases in the dates of withdrawal of the SAMS, although the magnitudes vary among the models. Trends are statistically significant in seven out of ten model simulations. Nine out of 10 models show positive and statistically significant (5% level) trends in the duration of the SAMS. Future changes in the SAMS were analyzed with six CMIP5 model simulations of the RCP8.5 high emission scenario. Most of the simulations show significant increases in seasonal intensities, early onsets, late withdrawals and durations of the SAMS. The simulations for this scenario project a 30% increase in the intensity from the current level by 2045-2050. In addition, the RCP8.5 scenario projects an ensemble mean 14-day decrease in the onset and 17-day increase in the withdrawal date of the SAMS by 2045-2050. Additionally, there is a lack of spatial agreement in model projections of changes in total wet season precipitation over South America during 2070- 2100. The most consistent CMIP5 projections are the increase in the total monsoon precipitation over southern Brazil, Uruguay and northern Argentina.

**Partners:**

University of California Santa Barbara, International Potato Center, Lima, Peru

**Links/sources for further information:**

<http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00412.1>[http://clivac.geog.ucsb.edu/wp-content/uploads//cjones\\_papers/clivar.spring.2013.pdf](http://clivac.geog.ucsb.edu/wp-content/uploads//cjones_papers/clivar.spring.2013.pdf)

**Case Study #2**

**Title:** Metamodeling to extend the domain of process-based ecological models.

**Author:** Karen Garrett (KSU) , Adam Sparks (IRRI) Greg Forbes (CIP)

**Type:** Breakthrough science

**Project description:**



Process-based ecological models used to assess organisms' responses to environmental conditions often need input data at a high temporal resolution. Such input data may not be available at a high spatial resolution for large areas, which can limit opportunities to use such models within a GIS framework.

### **Introduction / objectives:**

Use a metamodel framework to develop reduced form ecological models which retain the features of the original models. Validate the model using high resolution weather data. Apply the model to evaluate the effects of climate change on potato late blight.

### **Project results:**

In the initial validation process the metamodels used daily or monthly weather data, and their predictions maintained the key features of the original model. Metamodel predictions for both model construction and model evaluation data sets were similar to the results obtained with the original SimCast model. In the application to climate change effects the newly developed disease metamodel was used with three global climate models for the A2 greenhouse gas emission scenario for three 20-year time slices: 2000-2019, 2040-2059 and 2080-2099. Evaluations of five agroecosystems including the Andean Highlands, Indogangetic Plain and Himalayan Highlands, Southeast Asian Highlands, Ethiopian Highlands and Lake Kivu Highlands in Sub-Saharan Africa, where potato is an important crop were made. The model indicated that the average global risk of potato late blight increases initially, when compared to historic climate data, and then declines as global average temperatures continue to increase. Risk in the agroecosystems analyzed varied from a large increase in risk in the Lake Kivu Highlands in Rwanda to decreases in the Southeast Asian Highlands of Indonesia

### **Partners:**

CIP, Kansas State University, IRRI

### **Links/sources for further information:**

Sparks AH, Forbes GA, Hijmans RJ, Garrett KA, 2011. A metamodeling framework for extending the application domain of process-based ecological models. *Ecosphere* 2, art90. Sparks AH, Forbes GA, Hijmans RJ, Garrett KA, 2014. Climate change effects on the global risk of potato late blight. (in preparation).

## **Case Study #3**

**Title:** Revising gender roles in the management of local knowledge and decision making in climate change adaptation

**Author:** Cecilia Turin, Diana Giraldo, & Roberto Quiroz

**Type:** Social differentiation and gender

### **Project description:**

In the Altiplano agriculture to be successful in the production and management of the farming system women and men play different but complementary roles. While women hold more knowledge about genetic material, conservation of potato varieties, men are experts interpreting the biological indicators to predict climate. However, traditionally gender approaches have focused only women and have not included the role of other members of the household. We argue that we need to revise the gender approaches and gender studies in order to be fair and gender inclusive, especially with vulnerable groups. Based on research findings we propose revise the gender roles in times of change (environmental, market and social).

### **Introduction / objectives:**

To document the gender roles men and women play in the altiplano agriculture and demonstrate how crucial is the participation both and other members of the households in the success of the agricultural production, climate change adaptation and to ensure food security. to determine the cost benefit participation of women and men of different ages in the adaption to climate change

### **Project results:**

Men and women of all ages, play important and complementary roles in the development and maintenance of these strategies. Thus, while the participation of women is especially substantial in the selection and in situ conservation of germplasm, the role of men is especially important in the prediction of climate with bio-indicators to plan the agricultural strategies. Farmers have been able to develop a complex diversified portfolio of options to deal with climate uncertainty, risks and extreme events, which could be singled out as an example of climate smart agriculture based on traditional knowledge. Farm men and women as main holders of the ancestral agricultural knowledge play a key role in adapting strategies to climate change and food security of future generations. However, the weakening of family organizations and social networks, the scarcity of labor, the loss of local knowledge and skills due to migration and modernization of the altiplano society undermine the capacity to adapt strategies.

### **Partners:**

Rural communities, CIRNMA, CIP, SENAMHI-Bolivia, ALTAGRO

### **Links/sources for further information:**

Draft paper uploaded to CCAFS Intranet



## 6. Outcome indicators

### **Outcome indicator:**

Breeding strategies of regional and national crop breeding institutions in three target regions are coordinated, informed by CCAFS-led crop modeling approaches that are developed and evaluated for biotic and abiotic constraints for the period 2020 to 2050

### **Achievements:**

A community of practice with breeders and agronomists testing CIP tolerant potato varieties for 12 African countries was formed. All the participants learned how to use the Solanum model containing: parameters generated by CIP scientists plus the parameters generated with them for their trials. Participants also learned how to run climate change scenarios and how to simulate desirable traits. A paper co-authored by all the members of the community of practice, estimating yield gap using the model, for all the countries represented is being drafted.

### **Evidence:**

Attached first draft of the report which constitutes the basis for the paper plus a blog to be uploaded next week.

## 7. Leveraged funds

### Leverage funds #1

**Title:** Decadal Variability of the American Monsoons: An Assessment of CMIP5 Simulations – National Science Foundation, AGS-1126804

**Partner name:** University of California, Santa Barbara (UCSB)

**Budget:** \$30000

**Theme:** T4

### Leverage funds #2

**Title:** An Integrated View of the American Monsoon Systems: observations, models and probabilistic forecasts, National Oceanographic and Atmospheric Administration (NOAA), (NA10OAR4310170)

**Partner name:** UCSB

**Budget:** \$370984

**Theme:** T4