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Workshop report: Integrated Food Security Modeling in Eastern and Southern Africa

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IRRI

Integrated Food Security Modeling in Eastern and Southern Africa

Workshop Report

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Abstract

CCAFS organized a workshop on Integrated Food Security Modeling in Eastern and Southern Africa on 10-13 February 2014 in Nairobi, Kenya. The workshop was attended by participants from global, regional, and national institutions, including: the World Food Programme (WFP); the Food and Agriculture Organization (FAO); the UN Office for Disaster Risk Reduction (UNISDR), USAID Famine Early Warning System Network (FEWS NET); the IGAD Climate Prediction and Applications Centre (ICPAC); the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES); CGIAR Research Centers (CIMMYT, CIAT, ICRISAT, ICRAF, CIP, ILRI, AfricaRice, IRRI,); and the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS);

Workshop presentations and discussions accomplished the following objectives: The concepts and components of Integrated Food Security Modeling were explained along with descriptions, methodologies, and progress of work for current modeling activities in Eastern Africa and globally, including climate models, bio-physical crop models, and econometric models. Data and knowledge gaps, technical challenges, and uncertainties which constrain the accuracy of model outputs were identified, including lack of access to data in formats suitable for model input, data quality issues, errors arising from the aggregation of data collected at points to represent heterogenous areas, and the challenge of quantifying uncertainty when different models are combined. Challenges specific to the region include improving the skill of seasonal climate forecasts for East Africa, adopting the crop models to smallholder farming systems.

Institutions participating in in the workshop agreed to prepare a concept note for research on these topics and submit it to CCAFS for funding consideration under Flagship 2: Climate Information Services and Climate-informed Safety Nets.

Keywords

Seasonal climate forecasts; crop yield forecasts; crop models; econometric models; climate shocks; food security early warning

About the author

Michael Sheinkman, a food security analyst, is on special leave from the United Nations World Food Programme (WFP) to strengthen CCAFS partnerships with food security actors. Since 1991, Mr. Sheinkman has provided information and analytical support for humanitarian efforts to target projects in food security, humanitarian landmine clearance, public health, and refugees relief. At WFP's Regional Bureau for Asia, he led food security analysis and served as the focal point for Climate Change issues, providing technical advice for the design and implementation of research or risk reduction activities integrating food security and climate change adaptation. Contact: m.sheinkman@irri.org

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Contents

Acronyms

CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
ICRAF	World Agroforestry Centre
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IRRI	International Rice Research Institute
IGAD	Intergovernmental Authority on Development, African Union
ICPAC	IGAD Climate Prediction and Applications Centre (ICPAC)
AgMIP	Agricultural Model Intercomparison and Improvement Project
CPT	Climate Predictability Tool
CRAFT	CCAFS Regional Agricultural Forecasting Toolbox
DSSAT	Decision Support System for Agrotechnology Transfer
HIES	Household Income and Expenditure Survey
LSMS	Living Standards Measurement Survey
IGRM	IRRI Global Rice Model
IRI	International Research Institute for Climate and Society, Columbia University
UNISDR	The United Nations Office for Disaster Risk Reduction
NASA	National Aeronautics and Space Administration, USA
USAID	United States Agency for International Development
WFP	World Food Programme, United Nations
FAO	Food and Agriculture Organization, United Nations
RIMES	Regional Integrated Multi-Hazard Early Warning System
IMCASE	Integrated Modeling of Climate Change Impacts on Agriculture Productivity and Socio-Economic Status project, IRRI
FSNAU	Food Security and Nutrition Analysis Unit, FAO Somalia
SWALIM	Somalia Water and Land Information Management project
SISMod	Shock Impact Simulation Model, FAO/WFP
NGO	Non Governmental Organization
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
FEWSNET	Famine Early Warning System Network
CILSS	Permanent Inter-State Committee for Drought Control in the Sahel
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration

NMHS	National Meteorological and Hydrological Service(s)
NGO	Non-Governmental Organization(s)
NMHS	National Meteorological and Hydrological Service(s)
GIS	Geographic Information System(s)
GCM	Global Climate Model
IPC	Integrated Food Security Phase Classification
ENACTS	Enhancing National Climate Services
SAPARM	Satellite Assisted Pastoral Resource Management
HELIX	High-End cLimate Impact and eXtremes project
LEAP	Livelihoods, Early Assessment and Protection (LEAP) project, Ethiopia
PSNP	Productive Safety Net Programme, Ethiopia
ENSO	El Nino Southern Oscillation
AfSIS	Africa Soil Information Service
ISRIC	International Soil Reference and Information Centre
WISE	World Inventory of Soil Emission Potentials project, ISIRC

Introduction

Climate variability and the shock caused of extreme climate events pose a real risk to those whose livelihood is dependent upon the agricultural sector. Current scientific advances, however, cannot yet evaluate the impact of climate shocks on food crop productivity in a manner that effectively integrates the key processes involved: meteorological, biophysical, econometric, and sociological. State-of-the-art approaches and tools now exist for simulating meteorological processes (seasonal climate forecasting), biophysical process (crop and soil models), spatial distribution (remote sensing and geospatial analysis), econometric processes (price forecasting models), and impacts on household food security. The integration of these approaches offers potential for simulating the impacts of seasonal climate variability on agricultural output and food security among farm households and their communities.

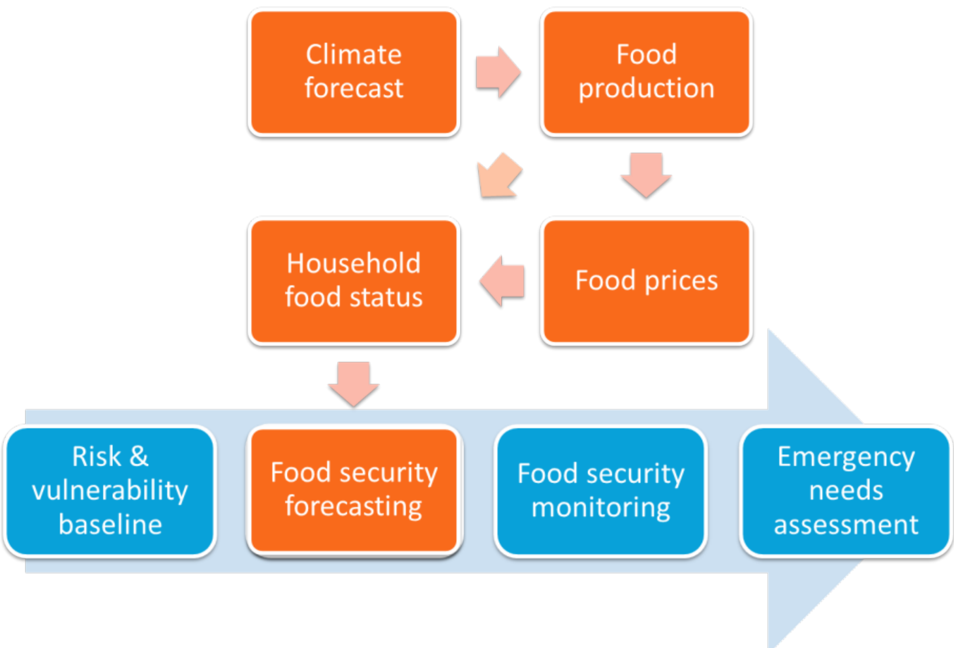

Figure 1. Schematic illustrating how component models can be integrated to fill a forecasting gap that exists in most food secuirity information systems.

CCAFS and IRRI jointly organized a workshop on Integrated Food Security Modeling on 10 - 13 February 2014 in Nairobi, Kenya. The workshop was attended by participants from global, regional, and national institutions, including: the World Food Programme (WFP); the Food and Agriculture Organization (FAO); UN Office for Disaster Risk Reduction (UNISDR); the USAID Famine Early Warning System Network (FEWS NET); CGIAR Research Centers (CIMMYT, CIAT, ICRISAT, ICRAF, CIP, ILRI, AfricaRice, IRRI,); the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS); the IGAD Climate Prediction and Applications Centre (ICPAC); the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES).

Presentations and discussions accomplished the following workshop objectives:

1. Present the concepts and components of Integrated Food Security Modeling and shared descriptions, methodologies, and progress of work for modeling activities currently underway in Eastern Africa and globally, including climate models, bio-physical crop models, and econometric models;

2. Identify challenges and uncertainties which constrain the accuracy of model outputs, including lack of access to data in formats suitable for model input, data quality issues, uncertainty or errors arising from methods of interpolation and extrapolation used to create gridded climate datasets, errors arising from the aggregation of data collected at points to represent heterogenous areas, and the challenge of quantifying uncertainty when different models are combined; and

3. Identify common interests and potential synergies between modeling activities along with follow-up actions in East Africa to faciliatate use of integrated models to simulate impacts of climate variability on food security and climate risk management under different scenarios and policy environments.

Workshop presentations provided descriptions of the objectives, methodologies, and current status of various modeling initiatives and activities currently underway in Eastern Africa, in Asia, and at global level. These national, regional, and global efforts include: regional Climate Outlook Forum events in East Africa; national Climate Outlook / Monsoon Forum events that are supported by RIMES; supporting national meteorological services to create historical gridded climate datasets from merged satellite and meteorological station data; Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), a recently released NASA global gridded climate dataset; creating a prototype medium term warning system for Africa (ClimAfrica); development and testing of the CCAFS Regional Agricultural Forecasting Tool (CRAFT) which includes the Climate Predictability Tool (CPT) developed by IRI; use of IMPACT to model impacts of weather extremes in major producing countries on global food supplies by CIMMYT; merging ORYZA 2000 and the IRRI Global Rice Model (IGRM); and the FAO/WFP Shock Impact Simulation Model (SISMod) which simulates the impacts on household food security caused by climate and food price shocks.

Discussion sessions facilitated an exchange of ideas on opportunities for enhanced collaboration and expanded use of the outputs. Interest was expressed to explore the feasibility of using integrated models to simulating the impacts of different policy options for food security and climate risk management. Participants also identified constraints on modeling efforts, including: lack of access to data in formats suitable for model input; data quality issues; method of interpolation and extrapolation used to create gridded data; and measures of uncertainty when models are combined.

Institutions participating in in the workshop agreed to collaborate on a concept note for research on these topics and submit it to CCAFS for funding consideration under Flagship 2: Climate Information Services and Climate-informed Safety Nets.

Workshop Program

Workshop Opening

Introduction and Workshop Objectives

James W. Hansen, International Research Institute for Climate and Society (IRI)

CCAFS Theme 2 Leader introduced the workshop by briefing participants on the mandate and structure of the Climate Change, Agriculture, and Food Security (CCAFS) research program of the CGIAR. CCAFS is a strategic partnership of the global change and the international agriculture research communities. It involves all 15 CGIAR centers and is the mechanism for organizing and funding climate-related work across the CGIAR. Currently, outcome focused research activities are being implemented in five (5) target regions, including East Afric, West Africa, South Asia, Southeast Asia, and Latin America.

Dr. Hansen described the rationale for integrated food security modeling as providing a pathway towards a unified approach for two distinct communities of practice: the agricultural research and development community and the food security community. Climate variability and the shock caused by extreme climate events pose a real risk to those whose livelihood is dependent upon the agricultural sector. He described the possible outcomes of climate shocks at household / farm level, which range from: forfeited opportunities; to hardships, caused by reduced incomes and/or increased prices for food; to crisis, involving loss of livelihood and/or selling of productive assets. Dr. Hansen emphasized the value of timeliness when considering information in support of responses that mitigate hardship and prevent crises.

Dr. Hansen presented a conceptual framework for Integrated Food Security Modeling and discussed the potential for simulating the impacts of seasonal climate variability on agricultural output, food prices, and food security at household and community levels. State-of-the-art approaches and tools now exist for simulating meteorological processes (seasonal climate forecasting), biophysical process (crop and soil models), spatial distribution (remote sensing and geospatial analysis), econometric processes (price forecasting models), and impacts on household food security. Dr. Hansen then posed a series of questions to the research community and the humanitarian response practitioners. His questions for researchers, included: "Are the models and data adequate ?" "How can uncertainties associated with forecasting components (i.e. weather, crop yields, prices, food security) and their integration be quantified probabilistically to facilitate informed decisions and early action ?" "Are there easy wins to add both scientific rigor and improved integration of models in order to increase the accuracy and resolution of food security forecasting ?"

His questions for the practitioners included: "Can model-based food security forecasting play a role in increasing decision lead time ?" "What are the challenges to incorporating probabilistic information into decision-making ?" "What additional information do you need and what is its potential value ?"

Dr. Hansen outlined four (4) objectives for the initial two days of the workshop: (1) Foster mutual awareness of the relevant organizations, initiatives, and modeling tools in Eastern Africa; (2) Identify the technical and practical challenges of integrating different modeling tools to forecast household food insecurity; (3) Initiate a collaborative process to pilot and test integrated modeling to forecast household food insecurity; and (4) Explore if and how model-based forecasts of food insecurity might enter into response decision-making in Eastern Africa.

The third day of the workshop was reserved to develop the outline of a concept note for integrated food security modeling in East Africa.

Dr. Hansen stated his hope that this workshop results in concrete actions that contribute to more timely better targeted food security interventions, including: strengthened partnership between the agricultural research and the operational food security response communities; identification of "easy wins" or "low-hanging fruit" that will benefit the food security response community; a Proof-of-Concept study for fully integrated food security modeling; and one or more concept notes for CCAFS Flagship 2 projects, focused on East Africa.

Information needs of Humanitarian Response agencies

Elliot Vhurumuku, World Food Programme, Regional Bureau for East Africa

Mr. Vhurumuku briefed the participants on the information needs of agencies responsible for meeting humanitarian needs following natural disasters and/or during conflicts, including: What are Humanitarian Response agencies; why information is needed by these agencies; and what types of information are required. He provided a definition of humanitarian assistance as aid and action designed to save lives, alleviate suffering and maintain and protect human dignity during and in the aftermath of emergencies. He identified the characteristics that differentiate humanitarian assistance from other forms of foreign assistance and development aid as generally being of short duration and governed by the principles of humanity, neutrality, impartiality, and independence.

Mr. Vhurumuku identified different types of entitites which can be involved in providing humanitarian assistance, including: governments; individuals; communities; international and local Non-Governmental Organizations (NGO); multilateral organisations; research organizations; domestic organisations; and private companies. He described the traditional responses to humanitarian crises, including: material relief assistance and services (shelter, water, medicines etc.); emergency food aid (short-term distribution and supplementary feeding programmes); and relief coordination, protection, and support services (coordination, logistics and communications). Humanitarian assistance can also include: reconstruction and rehabilitation; disaster risk reduction and preparedness; early warning systems; contingency stocks; and planning.

Mr. Vhurumuku explained to the participants why information is needed by humanitarian response agencies. As financial and human resources are always limited and usually insufficient to meet all humanitarian needs, information is critical to identify vulnerable groups in the overall populations and their specific needs. Agencies and entities have different information requirements, depending upon their mandate and the scope and scale of their operations. Information priorities differ with: the type of hazard and the level of exposure of the population to that hazard; the socio-economic conditions of households; seasonality; and the purpose - emergency response, recovery, or development.

Humanitarian response agencies primarily use information for one or more of the following purposes: develop a strategy; consider alternative responses; decide upon a strategy for response; and/or prepare a proposal for funding.

Mr. Vhurumuku identified the information requirements, including: who are the most vulnerable; how many people are affected; extent and scope of damages; accessibility constraints; security concerns; who are the actors and stakeholders; what assistance has already been delivered or promised; priority sectors for response (e.g. food or non-food); types of interventions needed and proposed; the financial requirements; the financial gap between needs and resources available; risks; and capacities. He listed the types of information needed to answer these questions, including: agriculture, food security; water and sanitation; health services; education; transportation and storage infrastructure; security and protection of vulnerable groups. Climate conditions can impact agriculture, food security, water and sanitation, health, and transportation / storage infrastructure.

A timeline was presented along with analyses needed at each stage. He listed WFP's specific information requirements to design programs of humanitarian response, including: the total population affected and the number that need food assistance, disaggregated by geographic areas; what are the gender disaggregated needs; who are the vulnerable groups; what are the monthly food assistance needs, disaggregated by geographic areas; what market interventions are needed, if any; distinguish between chronic food insecurity and acute/transistory food insecurity, so these can be addressed separately; distinguish between food assistance needs and livelihood needs; and project the impact of shocks for planning purposes. Many of the decision processes required for program design in the food security sector involve multiple stakeholders. The goal of these multi-stakeholder processes is to reach consensus on: priority areas, needs and transfer modalities; key factors; livelihood patterns; the capacity development needs of implementing partners; the strategic alliances needed between partners and stakeholders; and lessons learned and best practices.

In conclusion, Mr. Vhurumuku briefed the participants on the four (4) pillars of food security: Availability; Access; Utilization; and Stability/Vulnerability. He then listed a range of humanitarian programmatic response activities that address food insecurity.

Session 1: From Climate to Production

"Production Forecasting: Making the Climate – Crop Model Connection."

James W. Hansen, International Research Institute for Climate and Society (IRI), Columbia University. CCAFS Theme 2 Leader

Dr. James W. Hansen briefed the participants on the mechanisms and challenges associated with integrating seasonal climate forecasts with crop yield models. He described sources of predictability, including: antecedent soil conditions; historic climate; climate forecasts; within-season monitoring of weather; environment; and crop status. He presented the basic concepts of yield forecasting, including the challenge of scale mismatch between seasonal climate forecasts and crop models. He identified methods for making the connection between climate-model and crop-model. Dr. Hansen described the resources that CCAFS has available to assist, including: high resolution historic climatologies; the CCAFS Regional Agricultural Forecasting Toolkit (CRAFT); connections to the climate science community; and connections to the agricultural modeling community.

Dr. Hansen described some of the challenges associated with integrating seasonal climate forecasts and crop yield models to forecast agricultural production. He described the goal of production forecasting as extending the lead time for estimates of agricultural production to earlier in the growing season or even before the season starts and cautioned that the time scale of production forecasting does not cover monitoring actual yield at end of the season nor assessing the impacts of climate change. He identified and described sources of predictability when forecasting crop yields, including: initial and monitored soil moisture; the seasonal climate forecast; monitored weather; and status of vegetation. As agricultural production is a function of yield and area, the spatial scale needs to be considered. One challenge to integrating seasonal climate forecasts with crop models is the scale mismatch between the two. Seasonal climate forecasts are generated at global and/or regional scales with data representing values averaged over large areas (grid format), while crop yield models are designed for use at the level of an individual plot or field (point format). End users of the production forecast require some level of spatial aggregation for decision making, particularly those in in the humanitarian response community.

Dr. Hansen described the basics of yield forecasting and distinguished between the climate and model components of uncertainty. The relative contributions of the two changes through the growing season, with uncertainty due to climate diminishing as the season progresses. Current best practice takes advantage of this by simulating crop yield using observed weather data as inputs to the model through the current date and sampled historical data from prior years with similar patterns. This provides a probability distribution that narrows with time as observed weather replaces weather sampled probabilistically. Reducing climate uncertainty by incorporating seasonal forecasts will have greatest benefit for forecasts made early in the cropping season. Reducing model error using an improved model, improved quality of model inputs, and assimilating the monitored state will have the greatest benefit for forecasts made late in the cropping season.

Dr. Hansen described four approaches to connect climate and crop models and described advantages and concerns about each:

1. Classification and Analog Methods: Classification of climate predictors to select an analog year from the historical record to use as inputs to a biophysical crop model;

2. Stochastic Disaggregation: Use of a statistical climate model and a stochastic generator to prepare synthetic daily weather inputs to a biophysical crop model.

3. Daily Climate Model Output: Use of a downscaled dynamic climate model and a stochastic generator to prepare synthetic daily weather inputs to a biophysical crop model; and

4. Statistical Prediction of Crop Simulation: Use of a downscaled dynamic climate model in combination with observed weather and a biophysical crop model as inputs to a statistical

yield model. To provide an example of this approach, Dr. Hansen described research to forecast wheat yield in Queensland, Australia.

Dr. Hansen described the challenges of spatial aggregation associated with forecasting agricultural production over large areas when the models and tools were designed to forecast yield at a point. He described the aggregation error from applying point models to large areas that include heterogenous environments. Aggregation involves sampling that heterogeneity in both probability space and in geographic space, requiring a lot of data. Mapping where crops are growing remains a major challenge.

Dr. Hansen concluded by identifying resources available from CCAFS and/or IRI:

- Enhancing National Climate Services (ENACTS): High-resolution historic climatologies, obtained through merging station and satellite data. IRI has assisted in the development of developed 31-year daily climatologies for Ethiopia, Tanzania, Madagascar, and currently assisting countries in West African that are members of CILSS.

- Climate Hazards Infra-Red Precipitation with Stations (CHIRPS) is a gridded rainfall dataset created by combining satellite imagery with meteorological station data. It covers 50°S–50°N (all longitudes) from 1981 to near-present, creating a 30 year time series.

- CCAFS Regional Agricultural Forecasting Toolbox (CRAFT), a software platform to support within-season forecasting of crop production. CRAFT has been designed to be free, open-source, and model-independent. It incorporates the following functions: support for multiple biophysical crop models; a stochastic weather generator; management of spatial data and spatial aggregation; probabilistic analysis; post-simulation calibration; and visualization of the results as graphs and maps. Potential applications include: analysis of forecasts and hindcasts; analysis of climate risk; and comparative analysis of different climate change scenarios.

- As a research program involving all fifteen (15) CGIAR centers, CCAFS has access to a wide range of expertise in agriculture, including: crops, farming systems, livestock, fisheries, forestry, agro-forestry, water resource management, and food policy analysis.

- Connections to the climate and agricultural modelling communities.

"Potato Yield Gap Analysis in Sub-Saharan Africa through Participatory Modeling: Optimizing the Value of Historical Breeding Trial Data"

Dieudonné Harahagazwe, International Potato Center (CIP). Co-Authors: R. Quiroz, D. Harahagazwe, B. Condori, C. Barreda, F. de Mendiburu, A. Amele, D. Anthony, E. Atieno, A. Bararyenya, A. A. Byarugaba, P. Demo, J. Guerrero, B. Kowalski, D. Anthony Kude, C. Lung'aho, V. Mares, D. Mbiri, G. Mulugeta, B. Nasona, A. Ngugi, J. Njeru, B. Ochieng, J. Onditi, M. Parker, J. M. Randrianaivoarivony, E. Schulte-Geldermann, C. M. Tankou, G. Woldegiorgis and A. Worku

Dr. Harahagazwe briefed workshop participants on the results of a study conducted by the International Potato Center (CIP). The objective of the study was to determine the gap between actual and potential yields for potato production in developing countries. The study used SOLANUM, an open source potato production model, which simulates potential growth under conditions of water limitation, nitrogen limitation, and frost. The study evaluated yield gaps for twelve (12) varieties/clones: Victoria (Asante); Dosa, CIP395112.9; Guassa (CIP384321.9); Gudene (CIP386423.13); Kenya Mpya (CIP393371.58); Unica (CIP392797.22); Meva (CIP377957.5); Lulimile (Tigoni); Diamant; CIP396038.107; and CIP396036.201. African countries that participated in this study include: West Africa – Nigeria; Eastern and Central Africa - Burundi, Rwanda, Kenya, Uganda, Tanzania, Democratic Republic of Congo, Ethiopia; and Southern Africa - Angola, Malawi, Madagascar Mozambique. A variety of methods were used to downscale rainfall data to one-kilometer resolution.

"Data for Crop Models: Needs and Constraints"

Kindie Tesfaye Fantaye, International Wheat and Maize Improvement Center (CIMMYT Ethiopia)

Dr. Fantaye briefed the participants on CIMMYT's experience with dynamic crop models, including sources of uncertainty and data input requirements. He discussed the importance of climate forecasts to different stakeholders, including farmers, government ministries and institutions, relief organizations, and donors and identified the need to make climate forecasts useful for decision making by these stakeholders at different levels. For agricultural purposes, climate forecasts need to be interpreted in terms of production outcomes at the scale that decisions are actually made, if farmers are to benefit. This is the challenge that has stimulated CIMMYT's interest in linking climate models with crop models with the goal of supporting decision-making at different levels.

Dr. Fantaye summarized the history of efforts to link seasonal climate forecasts with crop models: first using El Nino Southern Oscillation (ENSO) to select historical analog years as inputs to climate models; followed by use of coarse resolution Global Climate Models (GCM) outputs, and current efforts utilizing finer resolution Regional Climate Models. Decision support systems involving integrated modeling tools are needed to address the challenges posed by increasing climate variability as well as adaptation to progressive climate change, at a time of increasing population and demand for food commodities. He described how dynamic crop models, such as the DSSAT biophysical model can run be run at different temporal resolutions (daily, seasonal, and annual), as well as different spatial resolutions (site/field, country, region, and global), but cautioned that uncertainty increases as you move from site/field to national and global scales. He described how IMPACT model simulations can be used to analyze food security at different spatial and temporal scales, accompanied by a similar caution about how uncertainty varies at different spatial and temporal scales. He cautioned that, while integrating multiple models has tremendous potential, uncertainty increases as we attempt to link different models.

Dr. Fantaye discussed uncertainty in crop models, emphasizing that the usefulness of model outputs for decision making depends on the level of uncertainty associated with those outputs. Uncertainty of outputs is determined by the quality of input data and the degree of model calibration. He described in the types of data used as inputs to crop models and their sources, including: climate, soil types/properties, genetic properties of crop varieties, and agricultural management practices. For daily climate data sources he compared and contrasted weather station measurements; output from weather generator software; remotely sensed data from satellites; and weather forecasts (downscaled from GCMs at different spatial scales). The primary challenge with climate data is adapting it to match the spatial scale required by process based crop models, especially when utilizing coarse resolution climate models outputs as inputs to crop models that were designed for use at site / field plot level. Dr. Fantaye described efforts to develop global, regional, and national soil databases by FAO, AfSIS, and ISRIC-WISE. However, these databases do not contain sufficiently detailed information on soil properties and the use of generic soil types as inputs increases model uncertainty. Crop models respond to specific crop traits. However, there are many crop varities for which genetic coefficinets are not available, including the local varieties grown by the majority of small-holder farmers. In the absence of genetic coefficients, generic crop varieties are used as inputs which increases model uncertainty. Infromation on crop management practices used by small-holders is diverse, varying with soil type and climate zone. The use of "representative" or average management practices as inputs increases model uncertainty.

In conclusion, Dr. Fantaye emphasized that linking crop & climate models increases relevance of both in managing climate risks in agriculture; uncertainty of model prediction can be improved by improving quality of input data; improving the skill of seasonal weather forecasts and matching data availability to scale of model operation will reduce model uncertainty; as will improved quality of soil types, crop varieties, and management practices.

Session 2: Climate Services in the Region

"Climate Services in East Africa: Capacities and Gaps"

Ruby Rose Policarpio, Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)

The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) is an international and intergovernmental institution, owned and managed by its Member States, for the purpose of providing early warning services for natural hazards, including: Weather and climate forecasting and research; Sectoral Climate Risk Research; Core regional observation and monitoring networks; maintaining a Regional Tsunami Watch; Capacity Building and support to National Meteorological and Hydrological Services (NMHS) of its Member States and Collaborating Countries; and data sharing for early warning;

RIMES supports national meteorological and hydrological services to convene Monsoon Forum / Climate Outlook events to disseminate the seasonal climate forecast and to assess the potential impacts on various sectors in collaboration with other stakeholders. The following countries are convening or have convened seasonal climate forecast events: Philippines; Myanmar; Cambodia; Lao PDR; Vietnam; Indonesia; Timor-Leste; Bangladesh; Nepal; Sri Lanka; Maldives; and Mongolia.

Monsoon Forum / Climate Outlook events bring together technical institutions involved in generating climate and early warning information, and the potential users of such information including government agencies, international organizations, NGOs, donors and others. Forums events assist potential users of climate forecasts to understand and use information for early warning of potential climate related risks and in enhancing preparedness planning, on a regular and seasonal basis. The outputs serve as platform for iterative risk management. Forum events assist climate scientists and meteorologists to understand end-user's information requirements. They encourage climate forecast applications in different climate-sensitive sectors and the events provide a long-term process for better understanding risks. The agenda of a typical Monsoon Forum includes: review of the seasonal forecast performance in the previous season and actions taken by users in response to anticipated impacts; presentation of the seasonal climate outlook and discussion of potential impacts; formulation of precautionary and preparedness measures for the coming season by different sectors; discussions about technical limitations to sector-specific decision needs; and topics and current issues related to hydro-meteorological and geophysical hazards.

RIMES is supporting its Member States and Collaborating Countries to establish Agro-Advisories Systems to translate the forecast products to practical advice for farmers. Various weather forecast products are assessed by experts who assess the impact on agriculture; communicate an advisory to the local NGO that interacts directly with the farmers. These advisories are evaluated through feedback mechanisms, which result in fine tuning the weather forecast producgts and improve the agro-advisory options. Capacity building is a critical component of providing agro-advisories to farmers. To effectively utilize the climate forecast, farmers need to be informed of the risks, as well as the potential gains. Ago-advisories are both crop and location specific and require interpretation. For those reasons, RIMES does not encourage sharing of raw climate and forecast data with farmers, except as part of a capacity building activity.

National assessments of capacities and gaps should be based upon the following indicators: capacity to produce / access climate information; capacity to package climate information for end-users; capacity to disseminate information; and capacity of legislative / governance framework to support generation, dissemination, and utilization of climate information to enhance decision making.

Ms. Policarpio concluded her presentation with recommendations, including: Upgrade and/or densify the observation network in most countries; Capacity building of NMHS to generate forecast products of different timescales; Capacity building of NMHS to analyze forecasts using national / local context; Tailoring Climate Outlook Forum events to specific sub-regions or localities to enhance relevance for agriculture and food security stakeholders; Integration of climate monitoring information, forecast, and agriculture and/or water resources assessments; Decision-support tools to facilitate generation of agro-advisories; Capacity building for institutions to translate forecasts into an impact outlook and response options; Capacity building of end users; and need for feedback on relevance and usability of available climate services.

"CLIMAFRICA – a Prototype Medium Term Warning System"

Selvaraju Ramasamy, Food and Agriculture Organization (FAO)

Dr. Ramasamy briefed the participants on FAO efforts to establish CLIMAFRICA, a prototype Medium Term Warning System for Africa. With a timeframe of five to ten years, CLIMAFRICA is intended to fill the gap between seasonal forecasts and long-term impact scenarios and to identify the future areas of concern, including hotspots of vulnerability and food insecurity. The approach involves the following components: Identify the factors (physical, bio-physical and socio-economic) that make particular groups and locations vulnerable to food insecurity and environmental changes; define indicators for the dominant factors which influence vulnerability; and define thresholds and monitor progress towards critical zones, where the adaptation potential of the environment and human population is at immediate risk of being exceeded.

Dr. Ramasamy explained the methodology of the CLIMAFRICA prototype. Indicators are used to quantify spatial variations in key variables of agricultural environments related to climate, water availability, suitable soils and topography for agricultural uses. These indicators can refer to either agricultural resource availability or agricultural resource poverty. Agricultural resource poverty is a structural component of environmental poverty. Environmental poverty is also linked to land and water degradation that has arisen due to managerial factors. In the current continent-wide approach managerial factors are not considered (e.g. fertilizer use, soil conservation practices) as they are location-specific . However, the potential exists for these to be included later for more area-specific studies. Four (4) components of agricultural resource availability are assessed separately using a common scale (0-100), including: a Climate Resource Availability Index; an Irrigation Water

Availability Index, a Soil Resouce Availabiltiy Index; and a Topographic Resource Availability Index. These thematic indices are combined as raster themes, with the same spatial scope and resolution, to produce an Agricultural Resource Availability Index and an Agricultural Resource Poverty Index. These indices are overlaid with population density maps to identify hotspots of vulnerability and areas where agricultural resources are constrained.

CLIMAFRICA is intended to fill the gap between seasonal and long-term impact scenarios. To that end, the project is mapping precipitation probabilities and annual precipitation trends and variability over the period 1901-2010. Maps of drought and wetness periods for the continent have been prepared using gridded annual Standardized Precipitation Index data over the same period.

One goal of the CLIMAFRICA prototype is to develop datasets that could also be applied at the seasonal timescale, recognizing the challenge of developing harmonized databases with reasonably good spatial resolution. To that end, the project is reviewing a number of datasets, including: climate predictability and forecast skill; past climate variability; climate impacts using ecosystem-based models; and case studies of socioeconomic implications in 10 countriesThe basic spatial resolution of CLIMAFRICA is currently 0.5 degrees. Work is ongoing to try to downscale available data, including: time series and trends of climateic variables, crop growing periods for the period 1981 – 2010; crop distributions and farming systems; and livelihood groups.

The CLIMAFRICA project is reviewing biophysical indicators combined with socioeconomic indicators to define areas of future concern for vulnerability and food insecurity in terms of exposure, adaptive capacity, and sensitivity. Data being evaluated by CLIMAFRICA for exposure includes: coefficient of variation of interannual rainfall, coefficient of variation of monthly rainfall, risk of cyclones, risk of floods, projected sea level rise, projected proportional change in rainfall, projected change in temperature, disaster events (numbers), disaster events (affected population). Data being evaluated by CLIMAFRICA for sensitivity includes: percent land under irrigation, net primary productivity, volume of rainfall per person on agriculture land, crowding on agriculture land, length of growing period, available soil moisture, soil degradation, slope, net primary productivity, major agriculture systems, own food production, protein consumption, dietary diversity, water withdrawals, and people living in water stress. Data being evaluated by CLIMAFRICA for adaptive capacity includes: Infrastructure, poverty, economic wealth, malnourishment, level education, expenditures on health, susceptibility to malaria, HIV prevalence, access to improved water, subscription to cellular network, travel time to nearest city, night lights data sets, and contribution of agriculture to the Gross Domestic Product.

Policymakers and development partners are intended as the primary audience for outputs of CLIMAFRICA which include maps of: Agriculture areas under stresses (past, present, future projection) such as water scarcity, shortage of land and/or labour, and lack of access to inputs; Projected changes in crop yields and crop suitability due to the multiple influences of changing climate and other environmental conditions; Changing risk patterns and extreme weather events, and its likely impact on biophysical and socio-economic characteristics; Changing socio-economic characteristics contributing to other underlying factors leading to areas of concerns and hotspots.

Session 3: From Production to Prices

"Weather Extremes: Linking Biophysical and Economic Models"

Sika Gbegbelegbe, International Wheat and Maize Improvement Center (CIMMYT)

Dr. Gbegbelegbe briefed participants on the results of a study to quantify biophysical impact of extreme weather on maize yields in USA and the resulting socio-economic impact on global food production, trade, and food security across the developing world. The scenario was based upon events that occurred in 2012, when a heat wave and drought in the USA was followed by a surge in global maize prices. To provide context for the research, she provided statistics illustrating how important USA maize production and exports are to the global food supply.

Dr. Gbegbelegbe briefed the participants on the spatial bio-econometric modeling framework used for the study. Site/farm level simulation using the DSSAT crop model was upscaled to the entire country using 27 FAO soil groups and weather data. These yield estimates were used as inputs to the IMPACT model to project world and domestic maize prices which affect both economic factors and nutritional status.

Climate models were used to simulate two conditions for the year 2012: a scenario without extreme weather and a scenario with extreme heat and drought. The socio-economic effects of the extreme weather were evalutated using IMPACT, a multi-market multi-country partial equilibrium model which focuses on the agricultural sector. It was developed by IFPRI to project national and global food security under alternative scenarios of population growth, income growth, and future climates. IMPACT can accommodate changes in crop (e.g. from maize to wheat) by both producers and consumers in response to price changes. The socio-economic scenario input to IMPACT was one of medium growth in per-capita income across the world over 50 years, from 2000 to 2050.

Dr. Gbegbelegbe discussed the model results, which included a large reduction in maize production coupled with a small reduction in maize consumption. Model outputs suggested that some countries would increase exports, including: Argentina; Brazil; France; Ukraine; Russia; Vietnam; and India. However, the projected reduction of USA maize exports would still result in a 17% increase in the global maize price and an increase of 1% in world prices for wheat and rice. Global consumption of wheat and rice was projected to increase slightly as consumers seek to substitute other food grains for increasingly expensive maize. When model outputs were compared to United States Department of Agriculture statistics for 2012, there was generally good agreement for impacts on maize production and consumption for both the USA and the rest of the world. However, there was poor agreement on the impact on net maize exports. It was found that the simulated impacts on exports and prices were more extreme than actuality because the IMPACT model assumes that stocks remain unchanged from year to year, whereas in the real world higher prices can stimulate selling-off stocks.

Projected impacts of the weather extreme on global food security, include: large increases in the number of people at risk of hunger in Sub-Saharan Africa, South Asia, and Latin America. The reduction in caloric intake for East and Southeast Asia was projected to be relatively small. She cautioned that while the projected numbers should not be used for planning purposes, the trends are most likely to be representative of what could happen in the real-world.

In concluding, Dr. Gbegbelegbe identified several issues needing further research, including: analysis of the frequency distribution of weather extremes over 10-50 years to assess the cumulative effect on production, prices, and food security; investigate methods of integrating partial equilibrium models with crop growth models; how to improve the accuracy of model outputs at country level; potential use of bio-economic models to support an adequate range of interventions, including social safety net programs; and methods to integrate the impacts of these safety net programs into the models.

"Integrated Modeling: Rice Supply and Price Forecast"

Valerien Pede and Tri Setiyono, International Rice Research Institute (IRRI)

Dr. Valerien Pede presented IRRI's research involving an econometric model, a biophysical model, and efforts to integrate the two. He described the IRRI Global Rice Model (IGRM), its purpose; advantages of this model over others; data sources used as inputs; the estimation and simulation tools; and the baseline projections outputs. He also described the ORYZA2000 crop simulation model.

The primary purpose of the IRRI Global Rice Model is the analyses of the global, national, and sub-national rice markets. IRRI Social Sciences Division uses IGRM to develop medium term (10-year) baseline projections of rice supply, demand, and prices for major rice producing and consuming countries. Policy analysis is conducted by simulating the impacts of domestic and international trade policies, subsidies, and price supports. IGRM is also used to assess the ex-ante and ex-post impact of new technologies, such as drought or flood tolerant rice varieties.

Dr. Pede described the IRRI Global Rice Model (IGRM), a partial equilibrium structural econometric simulation model which incorporates behavior equations for trade and stocks for different types of rice. It is capable of modeling sub-national supply response and consumption disaggregated by rural versus urban areas. Dr. Pede presented the two Representative Country Models and explained the price solving mode used for each: in model 1 country specific trade equations are used to solve for the world rice price; in model 2 the world price of rice determines imports and exports which are used to solve for the domestic price. Both representative country models includes supply, demand, trade, ending stock and market equilibrium conditions for 28 major rice producing, consuming and trading countries in Asia, Africa, Europe, Latin America, and North America. Dr. Pede presented the results of IRRI research using IGRM to model the effects of a supply shock on rice prices under baseline conditions and various scenarios of production increases or decreases in selected countries.

Dr. Pede descrbied ORYZA2000, a weather-driven and process-based rice growth and yield estimation model for rice. It captures complex and dynamic interactions among climate, agronomic management, crop characteristics, and soil properties that influence crop growth and resource use efficiency. Mechanistic soil water balance and nitrogen process modules are embedded in ORYZA2000, providing opportunity to evaluate water and nitrogen fertilizer footprints in the rice ecosystem especially in the humid tropics where irrigated rice areas with small-holding rice farmers are concentrated. In addition to estimating yield, IRRI Social Sciences Division is using ORYZA2000 to model the impacts of farmer adoption of rice varieties that are drought and submergence (flood) tolerant.

Dr. Pede briefed workshop participants on IRRI efforts to integrate ORYZA2000 and IGRM to model the impacts of shocks which affect yield, as well as ex-ante assessment of new rice breeding technologies and/or crop management practices. He noted the important role of inputs that cannot be provided by crop models, such as changes in harvested area and/or changes in policy. While crop model outputs have traditionally been used as inputs to economic modeling, IRRI is also investigating how IGRM market price outputs can provide feedback (inputs) to the ORYZA crop model and/or to decision support tools for crop management.

IRRI scientists recommended establishing a pilot project to develop and test a crop production forecasting system to increase the lead time of food security information analysis in East Africa. As an example, Val Pede and Tri Setiyono described a pilot test in the Philippines that IRRI is conducting in collaboration with CCAFS Climate Risk Management team. The Integrated Modeling of Climate Change Impacts on Agriculture Productivity and Socio-Economic Status (IMCASE) project is a joint IRRI-CCAFS effort to link the climate services and products of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA); IRRI's crop monitoring and modelling activities research under the Remote sensing-based Information and Insurance for Crops in emerging Economies (RIICE) project; and price modelling using the IRRI Global Rice Model. IRRI is providing capacity building for PAGASA in use of Geographic Information Systems (GIS). PAGASA is providing IRRI with access to its climate data and seasonal forecasting tools. IMCASE has proven to be an excellent platform for exchange of climate data.

As part of this pilot project, IRRI is collaborating with the Philippines Statistical Authority and the regional FAO project TCP/RAS/3409 "Improving Food and Nutrition Statistics in the Asia-Pacific" to analyse household level expenditure data collected through the national Family Income Expenditure Surveys and prepare it for use in a Shock Impact Simulation Model (SISMOD).

Session 4: Climate Impacts on Food

"WFP-Headquarters: Climate and Food Security"

Rogerio Bonifacio and Anna Law, World Food Programme (WFP)

Mr. Bonifacio and Ms. Law jointly briefed the participants on WFP's analytical products and the data and methodologies used to prepare them. Mr. Bonifacio first identified the three (3) units within WFP that are responsible for developing analytical products related to Food Security and Nutrition Analysis, Climate Change Risk Management, and Resilience and Prevention. Within WFP, the Food Security and Nutrition Analysis unit (OSZAN) is responsible for agro-climatic, household, and market analyses. Analytical products include: food security monitoring systems; assessments of household food security and nutrion; nutrition analyses; economic and market analyses, and maps/spatial analyses using GIS. Agro-Climatic analysis is primarily used to provide early warning of drought, flood, climate anomalies, or extreme weather that may affect food security and/or livelihoods. Precipitation data and vegetation indices are monitored in real-time or near real-time. Analyses of long term data sets are conducted to identify and characterize hazards and to map geographic areas and populations that are vulnerable. These involve mostly global rainfall estimates and/or vegetation index products. Mr. Bonifacio illustrated his points with WFP maps and analytical products covering Syria, Sudan, Niger, and Ghana. He identified the key challenge for WFP as the interpretation of agro-climatic information to forecast potential impacts on cropland, crops, and livelihoods. To assess how these affect household food security, WFP staff analyse secondary data and organize baseline surveys to identify characteristics of households, population groups, and livelihoods that are vulnerable to food insecurity. They also monitor fluctuations in food commodity prices and analyze how the markets function.

Ms. Anna Law described how WFP uses its analytical products, some of which involve modeling, to support decision-making and design of its own operations and to advocate for interventions by governments, donors, and other humanitarian responders. WFP vulnerability analyses guide long-term macro-level decisions by governments, including food security policies, social safety net programs, and disaster risk reduction activities. Examples include the use of climate risk modeling in its Climate Adaptation Management and Innovation Initiative (C-ADAPT) project and in the Shock Impact Simulation Modeling (SISMOD) studies conducted jointly by WFP and FAO. Climate change impact modeling is used in the High-End cLimate Impact and eXtremes (HELIX) project to forecast impacts of 2 degree, 4 degree, and 6 degree warming on food security, under different adaptation scenarios. Food security monitoring systems and emergency food security and nutrition assessments guide humanitarian responses. For example, the Livelihoods, Early Assessment and Protection (LEAP) project has provided the Ethiopian government with a mechanism for scaling-up its Productive Safety Net Programme (PSNP) in response to severe drought or floods. LEAP uses the water requirement satisfaction index at beginning of season to predict the number of PSNP beneficiaries at the end of the season. The next step is to integrate seasonal forecasts into the analytical process in collaboration with meteorological agencies from Europe. PSNP beneficiary numbers are currently determined by field data collection, not using predictions.

Ms. Law presented examples of WFP analytical products and projects that support decision making at the household level, including: educating farmers about weather-index insurance in Senegal and Ethiopia, through the R4 Rural Resilience Initiative; provding grazing maps derived from vegetation index products to selected pastoralists in Ethiopia to assist with decisions about migration, through the Satellite Assisted Pastoral Resource Management (SAPARM) initiative of LEAP and Project Concern International; and providing tailored weather and climate information to smallholder farmers and pastoralists in Tanazania and Malawi assisting them to enhance agricultural or livestock production, through the Climate Services For Action Africa Project. One challenge is finding ways to link this information product to existing WFP / R4 project activities, such as micro-credit.

"Integrated Food Security Phase Classification (IPC)"

Methode Niyongendako, Regional IPC Coordinator for East Africa

Mr. Niyongendako briefed workshop participants on the purpose, methodology, and outputs of the Integrated Food Security Phase Classification (IPC). To meet the challenge of efficiently allocating limited resources, food security analysts working for governments, international agencies, and non-governmental organizations have developed a wide range of methodologies to classify the situations encountered and a diverse set of terms to describe their findings. The IPC system is an effort by many of those same institutions to provide common methodologies for classifying food security situations and a consistent terminology for describing the current conditions, trends, and potential scenarios. The purpose of the IPC is to enable a consolidation of complex analyses of food security situation to provide answers to the challenge of allocating limited resources: who is in need; when; how many people; and what should be done. It provides a set of tools and procedures (protocols) for classifying the nature and severity of current and projected food security situations. It provides a process for building technical consensus on the current and projected situation analysis.

An IPC analysis incorporates information from a wide variety of sources to classify food security based upon a convergence of evidence. IPC reference tables facilitate comparison of direct indicators with thresholds based upon international standards. Classification is based upon these direct indicators, when they are available. In the absence of the direct indicators, classification is made by inference from indirect indicators and contributing factors. The IPC Analytical Framework for Area and Household Classification is based upon four common conceptual frameworks:

1. Sustainable Livelihoods framework
2. 4 dimensions of Food Security - Availability, Access, Utilization, Stability
3. UNICEF framework for Malnutrition
4. Hazard, risk, and vulnerability framework

IPC provides methodologies for classifying an Acute situation in terms of its "Phase" and a Chronic situation by its "Level". Analysis worksheets are used to document the process of reaching technical consensus on the interpretation and classification of available data. Mr. Niyongendako presented maps depicting results of recent IPC analyses in East Africa at national and regional levels.

"Famine Early Warning Systems Network, FEWS NET III: Integrated Food Security Modeling in Eastern and Southern Africa"

Nigist Biru, FEWS NET Regional Technical Manager for East Africa

Dr. Biru briefed participants on FEWS NET activities in Eastern and Southern Africa, emphasizing research and interventions relevant to integrated food security modeling. FEWS NET activities support the US Government's food security strategy to sustainably reduce chronic hunger, raise the incomes of the rural poor, and reduce the number of malnourished children. The specific goal of FEWSNET is to sustainably prevent food insecurity and famine and to achieve the following objectives: Support to USAID to deliver early warnings of actual and potential hazards, food insecurity, vulnerability to food insecurity, and famine; Improve the quality, quantity, and timeliness of early warning information and predictions; and help build and/or improve sustainable local regional, and international capabilities to provide early warning of, and respond appropriately to, new and continuing threats of food security and vulnerability. She presented a map of countries where FEWS NET has a presence or is monitoring the situation remotely and described partnerships with US government institutions for analysis of remotely sensed data and modeling purposes.

FEWS NET mandate is to provide early warning and predictions of food insecurity at least 6 months in advance. FEWS NET uses scenario development as a tool

to reconcile their need to provide early warning with the inability to predict the future with certainty and applies it when developing their quarterly Outlook report.

Dr. Biru presented the nine (9) step process that FEWS NET uses to develop scenarios, explaining how key assumptions are developed to conceptualize how a food security situation may change over time. Development of key assumptions involves identifying factors relevant to food security that are expected to behave normally and identifying the timing, duration, and severity of shocks expected to occur during scenario period, both positive and negative. She differentiated between weak (general) and strong (specific) key assumptions and presented examples from the region of key assumptions for crop production, food prices, and the availability of pasture and water for livestock. She provided examples of other key assumptions including, climatic conditions, conflicts, existence of socal safety nets and emergency interventions; and the effectiveness of coping strategies. Currently, FEWS NET relies upon a consensus of experts from international organizations, national governments, and non-governmental organizations to develop key assumptions. Dr. Biru welcomed efforts to develop models and informed that FEWS NET would make efforts to incorporate them into the scenario development process.

"FAO/WFP Shock Impact Simulation Model (SISMod) for Food Security Monitoring and Analysis"

Cheng Fang, Food and Agriculture Organization (FAO) Trade and Markets Division

Dr. Cheng Fang briefed the participants on the Shock Impact Simulation Model (SISMod) which was jointly developed, by the Global Information and Early Warning System of the FAO Trade and Markets Division and the WFP Analysis and Nutrition Service, to provide quantitative of the ex-ante and ex-post impact of various types of shocks (market, economic, political, policy, climate, or agricultural production) on livelihoods and food security. SISMod is a MicroSoft Excel and Access-based tool that combines data sets from the World Bank, FAO, WFP and national sources on key household / livelihood, economic, market, and production data to model the effects of various key shock factors. It combines a household food status baseline with food security monitoring to forecast food security status across different populations, livelihood groups, and/or geographic areas. SISMod is used to support intervention decisions and wider policy and planning. To illustrate the potential uses of SISMod, Dr. Fang reviewed the types of information needed by humanitarian response agencies presented in the keynote presentation by Elliot Vhurumuku of WFP.

Dr. Fang presented the model structure used to simulate shocks and explained how SISMod works. The first step is the input of key parameters about a population and its food security and livelihood status. A household level baseline is established using data from the Household Income and Expenditure Surveys (HIES) or Living Standards Measurement Surveys (LSMS). The baseline includes household level information on income by source; total expenditure on food; food consumption, and the prevalence of undernourishment. Second, possible shocks are identified and the factors determined or adjusted for each type of shock. Shocks that can be simulated by SISMod include: agricultural production (crops and/or livestock); cost of agricultural inputs (fertilizer, seeds, subsidies); agricultural and non-agricultural wage rates; remittances and transfers; and macro-economic factors such as trade policies.

When the model is run, the outputs are analyzed in terms of impacts on income, total expenditures; total food expenditures; and food expenditures on each food group.

The primary data requirements for the baseline profile are: a nation-wide Household Income Expenditure Survey (HIES) or Living Standards Measurement Survey (LSMS); population data, disaggregated by geographic region (province and district) or by urban versus rural; and the population growth rate. The data required to model the impact of shocks includes market prices and other economic data; crop and livestock production data; historical climate data or output from a crop production forecast model; and a profile of disasters that can impact the country, including climate (drought/flood) geohazards (earthquake), and crop/livestock pests and diseases. Data is needed at both national and sub-national levels and from different time periods, to allow for the creation of time series.

SISmod simulates the impact of shocks due to climate variability or extreme weather events by: calculating the changes in crop/livestock production at local level; modeling indirect impacts on the markets and economy; modeling the impact of planned interventions (such as food aid or crop insurance payouts); and by incorporating data and reports from field assessments or food security monitoring systems. It also simulates household strategies for coping with shocks, including: changes to expenditures on food, housing, clothing, education, or medical; purchasing lower cost versions of same food items or lower cost commodities; and outmigration.

SISMod simulates behavior during shocks using a two-stage food demand system. In the first stage, SISMod allocates the total household expendures to food and non-food items, such as housing, clothing, fuel, education expenses, and medical care. In the second stage, SISMod allocates the total household food budget across each different commodities or food group, including: wheat; maize; other cereals; potatoes/tubers; vegetables; fruits; milk; fish; meat; beverages; and tobacco. Household food consumption of different commodities / food groups is converted to food calories (kcal) using a food composition table. Food calaries per household is used to calculate the proportion of the population that is undernourish, consuming less that the minimum daily energy requirement. Other SISMod outputs include: number of people who need food assistance after shock; the depth of hunger; the "depth" of hunger gap; and the Gap of Food Needs.

Dr. Fang explained that national implementations of SISMod have been completed for Pakistan, Bangladesh, Nepal, and Tajikistan. Implementations are underway for Tanzania, Niger, Nigeria, Malawi, South Sudan, and Cambodia.

Discussion Highlights

Exchanges between CGIAR scientists and representatives of the food security analysis and humanitarian response communities were facililitated using different mechanisms, including: a panel discussion ; plenary sessions; and during Q & A following the presentations. A panel discussion was organized to elicit demand(s) for climate forecasts and food security model outputs. The panel included representatives of USAID FEWSNET, the World Food Programme (WFP), and the Food and Agriculture Organization (FAO). General discussion sessions were conducted after each series of presentations to facilitiate the exchange of ideas on specific topics, including:

- Information Needs of the Humanitarian Response Organizations;
- Providing Climate Information for Crop Production Forecasting;
- Forecasting Food Security Impacts at Different Scales, Household to Global;
- Modeling Impacts of Different Policy Options; and
- Decision Support Systems for Early Warning

A summary of the discussions follows, in which needs, gaps, constraints, challenges, and opportunities have been identified.

Needs

Humanitarian response organizations identified managing climate risks in the immediate future is their primary need. There is considerable demand for technologies and tools that can help limit the impacts of climate variability on food production and livelihoods. Short-term and longer-term information requirements were were identified:

- Short-term: Projections of acute food insecurity 3 to 6 months in advance

- Longer-term: Identifying and quantifying the impacts of factors that are not captured by the information currently collected for food security analysis.

Several areas where forecasting and models could improve methods of analyzing food security were identified, including:

- Forecasting the beginning of the season and and the planting windows;
- Developing production scenarios from model outputs for crops, livestock, and grazing land; and
- Forecasting the impacts on livelihoods of different production scenarios at sub-national, national, and regional levels.

The translation of seasonal climate forecasts into impacts is currently performed by experts using collective experience in the region. For example, in the IPC analytical process a consensus of expert opinion assigns weights and determines the phase classification. Inferences of experts need to be validated, in the same way as model outputs. Methodologies from the research community are needed.

An incremental or modular approach is needed. Response organizations offered suggestions as to how model outputs could be incorporated into the current analytical process, starting with the translation of seasonal climate forecasts into probabilistic estimates of rainfall, onset date, and length of season, followed by the introduction of production scenarios based upon crop model outputs.

Experts and food security analysts working in regional institutions, such as ICPAC, were identified as the primary audience for probabilistic information, model outputs, and scenarios. Initially, these new tools need to be introduced as enhancements of existing products or to develop new products similar to what exists currently. It was suggested that region-wide forecasts of crop production would be a good starting point. Analysts working at national level could prepare scenarios which describe possible impacts and organize collection of data necessary to validate the model outputs, forecasts, and scenarios.

Analysis at the scales of subnational administrative unit (province, district, etc) and livelihood zone were identified as needed by the humanitarian response community. At national level, agricultural production data is usually collected and reported by administrative unit.

Decisions about planning policies, activities, and response interventions are made at the level of administrative units, as well. At regional level, experts often conduct analysis by livelihood zones and many countries in East Africa have also collected and analyzed baseline data by livelihood zones. Scenarios for production of major crops within an administrative unit or livelihood zone would facilitate their integration into the current analysis.

The need to share forecasts and model outputs beyond the research community was acknowledged. However, there is a need to clearly distinguishing between probabilistic information and the real-time monitoring information used in the current analyses. In addition, meaningful entry points need to be identified for the introduction of forecasts and model outputs. An example of a potential entry point was discussed - if a shift in the planting window was forecast, then this could be accompanied by production scenarios along with a forecast of the "lean season" duration under each scenario.

Qualitative: Model outputs will need to be confirmed by field observations which describe the impacts of a climate shock. Panelists expressed skepticism about whether humanitarian assistance would be initiated in response to forecasts and model outputs alone. As a result, panelists were hesitant about using deterministic forecasts of impacts on household food security. They cautioned against reporting model outputs involving numbers of people affected, because of political sensitivities on the part of governments and because revising these numbers later can be difficult. Including forecast numbers in scenarios is preferable.

Quantitative: Validation of model outputs is needed before there is sufficient confidence to include them in the current expert analysis. Panelists suggested to validate models at each step in the process rather than try to validate the integrated package, as food security analysts had become skeptical of "black-box" tools and solutions.

Gaps and constraints

Participants indentified gaps in data and knowledge which constrain efforts to incorporate models and tools into food security analysis, including:

- Lack of personnel with skills/capacity to run models and interpret outputs;
- Lack of understanding of the extent of international trade in food commodities, both formal and informal, and the impacts it has on household food security in the region -

although the East African Grain Council does have data on formal/informal trade across the region and commodity prices for some markets;

- Lack of understanding of the extent to which households access their food from markets versus their own production and how this varies by geographic area and livelihood group;
- Insufficient coverage of meteorological station data;
- Lack of uniform regional scale data on crops, including crop development cycles and which parts of crop cycle are most sensitive to variation in rainfall. Note: data may exist in some countries, but not as a standardized dataset across the region; and
- Insufficient socio-economic data to validate the Shock Impact Simulation Model.

Challenges

A fundamental challenge will be to improve the skill of seasonal climate forecasts in East Africa, upon which the other modeling efforts depend. March to May is the main rainy season in the region, but users perceive the regional forcast skill to be low. National meteorological agencies produce their own forecasts, but users perceive the consensus to be limited. Users have been advised to use downscaled forecasts, but the skill of these downscaled forecasts is perceived to be low, as well.

Global Climate Models (GCM) still have poor performance regarding daily rainfall amount and intensity. A comparative analysis of the performance of different models for different crops and/or different regions under different conditions is needed.

Modelling crop production by smallholders systems in Sub-Saharan Africa remains a challenge, because the main constraints on yield are factors other than water limitation, including:

- Multiple nutrient constraints that limit crop production;
- Lack of appropriate crop management;
- Poor seed quality;
- Extensive use of intercropping systems;
- Complex interactions within crop-livestock systems; and

- Diversity of environments found within the East Africa region.

Uncertaintly: The level of uncertainty in outputs from a single model can pose a challenge to its adoption by decision makers. That challenge is compounded when combining models as different as those simulating climate, crop production, prices, and food security. Despite the complexity involved, users want to understand the models. They do not want a 'black box'. Researchers will need to communicate the level of confidence in model results in a transparent manner. Aligning model outputs with decision cycles occuring at different timescales will pose further challenges.

Spatial aggregation. Models generate yield estimates at point scale, but the requirement is for information aggregated to larger scales, at which it can influence humanitarian response decision-making. Aggregating information from point (yield estimates) to grid (production estimates) will require a lot of data. Acquiring the information needed to meet model input requirements remains a challenge, but this is a broader issue affecting other sectors.

Opportunities

Participants were able to identify a number of opportunities:

- Incorporate global data products such as CHIRPS, ENACTS, and AfSIS soils.
- Make use of existing secondary data, such as livelihoods information collected at national level by governments and humanitarian / development partners, crop calendars, and cross-border trade flows.
- Some secondary empirical datasets may exist which are sufficiently accurate to be used for model validation purposes, such as: crop production statistics; prices of food items; and / or household food security status.
- Facilitate collaboration between stakeholders, each with their own data.
- SMS and crowd-sourcing can be used to collect data, reducing costs.
- Case studies can be developed at sites where good quality data exists, such as CCAFS benchmark sites.
- Use of climate forecasts as inputs to food security analysis can be expanded.

- Work with IPC to integrate model outputs into the decisions that analysts / experts are already making and incorporate food security analysts / experts into the model development process.
- Use a modular approach, so outputs can be shared at each step and feedback obtained from experts which can improve the models.
- Existing government decision support systems that incorporate model outputs can be strengthened, such as the Livelihoods, Early Assessment, and Protection (LEAP) early warning tool, adopted by the Ethiopian government as the mechanism for determining needs and initiating response planning.
- Existing private sector decision support systems that incorporate model outputs can be strengthened, such as agricultural insurance.
- Participatory platforms can be developed which facilitate the integration of information from research institutes to farmers and from farmers to research institutes.
- Model outputs can be compared to needs assessments findings.
- Participatory approaches can be used, starting with an analysis of options available to farmers and providing the results of that analysis to decision-makers and suppliers of agricultural seeds, intputs, and products.
- User requirements can be assessed so information products can be tailored.
- User perceptions of uncertainty can be documented along with how this perception constrains adoption.
- Farmers can be trained to understand model outputs and they can be asked whether they want/need this product.
- Efforts can be focused on crops grown by majority of farmers in countries whose food security is most affected by variations in prices.
- Links to the national meteorological services can be facilitated by ICPAC, RIMES, and / or IRI.
- Analysis of HIES / LSMS household survey data can be provided to FAO and WFP to facilitate development of a Shock Impact Simulation model (SISMod) for each country.

- CCAFS Regional Agricultural Forecasting Toolkit (CRAFT) can be used to forecast agricultural production. CCAFS can provide ICPAC and RIMES with the CRAFT software and training/support to use it.
- Exchange information about respective econometric models for comparative analysis.

Conclusion

The concepts and components of Integrated Food Security Modeling were explained along with descriptions, methodologies, and progress of work for current modeling activities in Eastern Africa and globally, including climate models, bio-physical crop models, and econometric models. Data and knowledge gaps, technical challenges, and uncertainties which constrain the accuracy of model outputs were identified, including lack of access to data in formats suitable for model input, data quality issues, errors arising from the aggregation of data collected at points to represent heterogenous areas, and the challenge of quantifying uncertainty when different models are combined. Challenges specific to the region include improving the skill of seasonal climate forecasts for East Africa, adopting the crop models to smallholder farming systems. Institutions participating in in the workshop agreed to prepare a concept note for research on these topics and submit it to CCAFS for funding consideration under Flagship 2: Climate Information Services and Climate-informed Safety Nets.

Appendix 1: Workshop Agenda

Monday, 10 February			
8:30	9:00	Registration	
Session 1: Workshop Opening (Chair: Michael Sheinkman)			
9:00	9:20	Workshop Introduction and Objectives	Jim Hansen
9:20	9:50	Introductions	Kevin Coffey and Alexa Jay
9:50	10:15	Information Needs of Humanitarian Response Organizations	Elliot Virumuku
10:15	10:45	Workshop photo Break	
Session 2: From Climate to Production – Focus on agricultural models (Chair: Selvaraju Ramasawmy)			
10:45	11:05	Making the Climate – Crop Model Connection	Jim Hansen
11:05	11:25	Downscaled Climate Forecasts for modeling roots & tubers	Dieudonne Harahagazwe
11:25	11:45	Modeling wheat and maize production in East Africa	Kindie Tesfaye Fantaye
11:45	12:30	Discussion: Integrating climate information and crop modeling	
12:30	1:30	Lunch	
Session 3: From Climate to Production – Focus on climate (Chair: Jasper Batureine Mwesigwa)			
1:30	1:50	Climate Services in East Africa, capacities and gaps	Ruby Rose Policarpio
1:50	2:10	CLIMAFRICA, a prototype medium term warning system	Selvaraju Ramasawmy
2:10	3:00	Discussion: Providing the climate information for production forecasting	
3:00	3:30	Break	
Session 4: From Production to Prices (Chair: Val Pede)			
3:30	3:50	Weather Extremes - Integrating model outputs into IMPACT	Gbegbelegbe Sika
3:50	4:10	Integrating ORYZA and IGRM models (IRRI)	Tri Setiyono
4:10	4:30	Impacts of supply shocks on prices	Simon Dradri
4:30	5:00	Discussion Modeling the impacts of different policy options? Decision Support Systems for Early Warning?	
5:00	6:30	Poster Session and Welcome Reception 1. Somalia Water and Land Information Management (SWALIM) 2. Integrated Phase Classification 3. Food Security Analysis Unit (FSNAU) for Somaia 4. Risk modelling of losses due to disasters in East Africa 5. Enhancing National Climate Services (ENACTS) 6. CCAFS Regional Agricultural Forecasting Toolbox (CRAFT)	 Hussein Gadain Methode Niyongendak Daniel Molla Animesh Kumar Kevin Coffey Jim Hansen
7:00		Workshop Dinner	

Tuesday, 11 February			
Session 5: Forecasting Climate Impacts on Household Food Security – Modeling (Chair: Rogerio Bonifacio)			
9:00	9:20	Prioritizing information for Decisions, the IPC	Methode Niyongendako
9:20	9:40	FAO / WFP Shock Impact Simulation Model	Cheng Fang
9:40	10:00	Assessing climate impacts on Food Security at FEWSNET	Nigist Biru
10:00	10:30	Discussion	
10:30	11:00	Break	
Session 6: Forecasting Climate Impacts on Household Food Security – Panel Discussion (Chair: Animesh Kumar)			
11:00	12:30	Panelists: FAO: Selvaraju Ramasawmy; Methode Niyongendako, Daniel Molla WFP: Elliot Vhurumuku, Simon Dradri, Rogerio Bonifacio FEWSNET: Nigist Biru, Nancy Mutunga	
12:30	1:30	Lunch	
Session 7: Towards Integrated Household Food Security Modeling –Gaps (Chair: Jim Hansen)			
1:30	3:00	Discussion: • Data gaps/data quality issues? • Research questions? • How to measure uncertainty when different models are combined? • Constraints on accuracy when different models are combined?	
3:00	3:30	Break	

Appendix 2: Workshop Participants

Name	Title	Email
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