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WWC1B: Regional Assessments of biophysical and economic systems

Overview of the suggestion for the establishment of the Grazing Reserve Bill and the Farmer – Herdsmen Rifts in Nigeria - Michael Adedotun Foundation

The marketing of Carrots and the advantage of using Bottle water and used plastic materials in the Federal Capital Territory Abuja Nigeria - Michael Adedotun Oke
Impacts and management strategies under climate change on maize yield in Brazil - Sentelhas, P. C.
The missing link - adding a spatial component to AgMIP's Regional Integrated Assessments (RIA) to upscale and map the impact of climate on crop production and economics - Davide Cammarano

WWC1D. Climate Change impacts on biophysical systems #2

Simulating the yield response of potato crops to projected climate scenarios for southern Chile using SUBSTOR-POTATO - Patricio Sandaña
Simulating the yield response of wheat crops to projected climate scenarios for southern Chile - Patricio Sandaña
Global crop production: adaptation options to temperature increase - Sara Minoli
Sensitivity analysis of maize grain yield to changes in climate elements, CO_2 and nitrogen fertilizer - Fabiana Bender
Adjusting Climate Model Bias for Agricultural Impact Assessment: the BAD-JAM project - Stefano Galmarini
Preliminary Results of a Simulation-Based Wheat Yield Forecast Framework for the US Southern Great Plains - Phillip D. Alderman
InfoCrop DSS aided adaptation to climatic risks in agriculture: Case study from farmers,Äô fields in India -S. Naresh Kumar

WWC2B: Advanced Computing and Machine Learning Applications for Agriculture

Experimental data sets for crop growth model calibration and validation in Latin America - Maurits van den Berg
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WWC2C: Data Assimilation and Seasonal Forecasting of Agricultural Shocks

Assimilating remote sensing observations in a sunflower crop model under uncertainty on soil properties – Ronan Trepos

WWC2E: Modeling the Causes and Cascading Impacts of Food Shocks

Implications of future climate variability on food security: a model-based assessment of climte-induced crop price volatility impacts - Hermann Lotze-Campen

WWC3B: Crop Model Intercomparison in Diverse Systems

Comparing the performance of SUBSTOR and CropSyst in five potato varieties under different model calibration strategies - Victor García-Gutiérrez

Additional Presentations

1A: Global Agricultural Modeling for development and climate analysis
"Good practice" and trade-offs in constructing agricultural development indicators for LMICs - C. Leigh Anderson
1B: Regional Assessments of biophysical and economic systems
The various problems associated into financing livestock production in the Northern Nigeria - Michael Adedotun Oke
1D. Climate Change impacts on biophysical systems
Soybean expansion in Europe analyzed with crop niche modeling under current and future climate conditions – Nicolas Guilpart
2D: Regional Assessments of biophysical and economic systems
Improving Model Design and Development with Stakeholder Engagement: What's in it for Them? - Wendy-Lin Bartels
3B: Crop Model Intercomparison in Diverse Systems
Multimodal ensemble approach to study elevated CO2 effects on wheat productivity - Mukhtar Ahmed
3D. Climate Change impacts on biophysical systems #2
Agricultural Vulnerability and Adaptation to Climate Change: Understanding and Contextualizing Evidence from Crop Simulations - Malcolm N. Mistry

Additional Posters

WWC1A: Global Agricultural Modeling for development and climate analysis
"Efficient Eco- Modern Farm Management as well as Climate Change adaption Western Nepal - Arjun Pande
WWC1B: Regional Assessments of biophysical and economic systems
Over view of the suggestion for the establishment of the Grazing Reserve Bill and the Farmer – Herdsmen Rifts in Nigeria - Michael Adedotun Foundation

The marketing of Carrots and the advantage of using Bottle water and used plastic materials in the Federal Capital Territory Abuja Nigeria – Oke Michael Adedotun Oke Foundation

WWC1C: Advances in Simulating Diverse Agricultural Systems

Effect of Plant Population Density on Growth and Yield of Artemisia (Artemisia annua L.) at Wondo Genet, Ethiopia - Nigussie Ashenafi

Rangelands resources of South Sudan boast a large number of animals available in significant numbers in all livelihoods zones except the tsetse fly-infested southwesterly Green Belt where only small ruminants may be found. the communities who keep the livestock also grow crops in a closely linked agro-pastoral production system. A sophisticated rhythm of seasonal mobility has sustained a large number of animals in the range, which by recent counts includes about 31 million livestock. - Keywords: Rangelands resources, agro-pastoralist, ruminants

WWC1D. Climate Change impacts on biophysical systems #2

Analyses of rainfall features and crop water requirements in chickpea production in central rift valley of Ethiopia - Lemma Mengesha

Forecast of Agricultural Calendar for Maize (Zea Mays) from Global Circulation Model in the Ruzizi Area (DRC) – Agronomist and reseacher in Agricculture meteorology. forcast of seasonal agriculture topics

WWC2C: Data Assimilation and Seasonal Forecasting of Agricultural Shocks

Combining satellite imagery and economic information for environmental and welfare impacts of deforestation reduction in Brazil - Joaquim Bento de Souza

Effect of rainfall variability on the crop growing season characteristics: case of smallholder farming in Hwedza district of Zimbabwe - Mugiyo Hillary

WWC3C: Soil nutrient and Water Management Strategies

WHEAT RESPONSE TO NITROGEN APPLICATION RATES AND TIMINGS - Mohammad Akmal

Effect of organic amendments at optimum irrigation level on maize yield, soil carbon dynamics - Haroon Shahzad

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Session 1A: Global Agricultural Modeling for development and climate analysis #1

Title: **Joining forces: linking AgMIP, ISIMIP and TWI2050 for assessing sustainable development pathways**

Presenter: Herman Lotze-Campen

Author: Lotze-Campen, Hermann[1]

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Abstract: Several initiatives are working at improving the scientific knowledge base for our understanding of how to achieve sustainable development. The agricultural sector is at the core of the interaction between various SDGs. AgMIP has developed an impressive range of scientific insights about climate impacts on agriculture, mitigation challenges, modelling of crop and livestock physiology as well as economic processes from local to global scales. ISIMIP (www.isimip.org) has generated an infrastructure and scenario protocol to harmonize climate impact assessments across a wide range of sectors. This growing network of impact modelling teams provides the basis for improved integrated assessments of climate impacts, adaptation, and mitigation. The World in 2050 (www.twi2050.org) will generate consistent pathways towards achieving the SDGs by 2030 and beyond. Also here, the links between agriculture, food, land use and climate have to play a key role. I will argue that the goals and processes of AgMIP, ISIMIP and TWI2050 have important overlaps. Given the lack of sufficient multi-lateral research funding for all these endeavors I will further argue that it is necessary to join forces and develop joint modelling protocols and data infrastructures, to make the best use of existing modelling capabilities in AgMIP and contribute effectively and efficiently to the joint goal of improving the capacities to assess future sustainable development pathways. This also requires defining key outputs to be produced and fed into the relevant policy

process, e.g. IPCC, High-Level Political Forum on sustainable development (HLPF), or the EAT-Lancet Commission on Food, Planet, and Health.

Title: **Reconciling global sustainability targets and regional action for food security and climate change mitigation**

Presenter: Juliana Dias and Bernardes Gil

Author: Gil, Juliana[1], Daioglou, Vassilis[2,3], van Ittersum, Martin[1], Reidsma, Pytrik[1], van Vuuren, Detlef[2,3]

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Abstract: The Sustainable Development Goals (SDGs) imply country-led implementation, however their success depends on the reconciliation of sustainability targets across different sectors and scales. Ensuring consistency between climate mitigation efforts and national agricultural policies is no trivial task and may involve significant trade-offs. Our study examines how the GHG emission intensity of agriculture (EIA) should evolve globally, regionally (Western Europe) and nationally (The Netherlands) under different socioeconomic pathways, so that the major aims of SDG-2 (i.e. food security) and SDG-13 (i.e. 2oC climate mitigation target) are achieved simultaneously. Results show that, by 2050, relative to 2010 values, EIA should decrease at all three levels – both when measured on a land basis (MtCO2eq/ha) and on a product basis (MtCO2eq/tonDM). Concerning the Dutch agricultural sector, the comparison of current and projected CH4 and N2O emission levels related to enteric fermentation, manure management and agricultural soils reveals the need for significantly more ambitious policy targets. Over 2010-30, assuming that food production remains constant, our model indicates that Dutch agricultural GHG emissions must decrease by 26% in absolute terms and 28% in EIA-product terms; however, the extrapolation of today's trends may ensure a reduction of no more than 5% and 8%, respectively. Besides shedding light on the interaction between climate and agricultural strategies, our analysis illustrates the application of cross-scale thinking in the operationalization of the SDG agenda and constitutes a step forward in bridging bottom-up and top-down research.

***Title*: Reconciling irrigated food production with environmental flows for Sustainable Development Goals implementation**

Presenter: Jonas Jägermeyr

Author: Jägermeyr, Jonas[1], Pastor, Amandine[2], Biemans, Hester[3], Gerten, Dieter[4]

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Abstract: Safeguarding river ecosystems is a precondition for attaining the UN Sustainable Development Goals (SDGs) related to water and the environment, while rigid implementation of such policies may hamper achievement of food security. River ecosystems provide life- supporting functions that depend on maintaining environmental flow requirements (EFRs). Here we establish gridded process-based estimates of EFRs and their violation through human water withdrawals. Results indicate that 41% of current global irrigation water use (997 km3 per year) occurs at the expense of EFRs. If these volumes were to be reallocated to the ecosystems, half of globally irrigated cropland would face production losses of >10%, with losses of ~20–30% of total country production especially in Central and South Asia. However, we explicitly show that improvement of irrigation practices can widely compensate for such losses on a sustainable basis. Integration with rainwater management can even achieve a 10% global net gain. Such management interventions are highlighted to act as a pivotal target in supporting the implementation of the ambitious and seemingly conflicting SDG agenda.

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Session 1B: Regional Assessments of Biophysical and Economic Systems #1

Title: **Adaptation strategies for Cotton-Wheat Cropping System of Punjab Pakistan under Changing Climate Scenarios**

*Presenter**:** Ashfaq Ahmad*

Author: Ashfaq Ahmad[1], Muhammad Ashfaq[2], Aftab Wajid1, Tasneem Khaliq[1], Ishfaq Ahmad[1], Shahzad Tahir[1], Fahd Rasul[1], Burhan Ahmad[3] and Gerrit Hoogenboom[4]

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Abstract: Climate change is a significant threat to crop production and food security in Pakistan. Increase in temperature and change in precipitation pattern lead to decline in production. The Cotton-wheat cropping zone is source of food and fiber in Punjab-Pakistan. It comprises 2.2-million-hectare area and 1.5 million farm families. The study was planned to evaluate the impacts of climate change on Cotton-Wheat cropping system and development of adaptation strategies in context of changing climate. For this study crop growth models (DSSAT and APSIM) were calibrated and evaluated on experimental field data to develop the robust genetic coefficients. Models were validated using farmers' field data. An extensive farm survey for 165 farms from the selected five districts Bahawalnagar, Bahawalpur, Lodhran, Multan and Rahim Yar Khan were conducted. Surveyed data of initial condition, crop management and soil characteristic were used to create the input files in both DSSAT and APSIM. The current climate data (1980-2010) was analyzed by using the available weather station data. Climate change

projections for the study regions were generated using output of the five selected General Circulation Models (GCMs) from the latest CMIP5 family for mid-century (2040-2069) under Representative Concentration Pathways (RCP 4.5) and 8.5. The five GCMs were selected to represent the uncertainty in projected temperature and rainfall changes based on five possible climate characteristics (cool/wet, cool/dry, hot/wet, hot/dry, middle). Trade of Analysis model for Multidimensional (TOA-MD) was used for economic analysis. Results of climate change scenarios showed that There would be increase in mean max. temperature of 2.5 °C and 3.6 °C and mean min. temperature 2.7 °C and 3.8 °C under 4.5 and 8.5 RCPs, respectively for mid-century (2040-2069) in Cotton-wheat cropping system. Decrease in rainfall would be about 33 and 52 % during cotton growing season and 36 and 42 % during Wheat growing season.

Title: **Influencing sustainability transitions for smallholder farming systems in Southern Africa**

Presenter: Sabine Homann-Kee Tui

Author: Sabine Homann-Kee Tui[1], Patricia Masikati[2], Katrien Deschemaeker[3], Givious Sisito[4], Buhle Francis[5], Elisha N. Moyo[6], Tariro Chipepera[7], Roberto Valdivia[8]

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Abstract: Uncertainties about future socio-economic conditions and impacts of climate change on smallholder farming systems challenge decision making towards resilient and sustainable food systems. This study illustrates how co-designing transition to more transformative sustainable farming systems can help preparing more conducive context for farming, where options cannot be tested in real life situations. We present a framework and outcomes on two future scenarios developed with local stakeholders combined with an integrated multi-modeling approach, and how they can be used to inform research, development and policy priorities, within local and national contexts. The case from Zimbabwe illustrates: 1. The consequences of following a sustainable development pathway or a fast economic growth pathway by 2050, where improved farm management and market participation, and removal of critical barriers to farming leads to halve poverty rates from the current 85% of the population living below poverty line. 2. Climate change would hamper the advances in productivity growth, with negative effects on staple food crops, while grain legumes increased both grain and stover. Farms with larger stocking density would face highest economic losses through feed deficits on rangelands, while the extremely poor, largely trapped in poverty, had fewer options to ensure food insecurity. For both, changing farm configuration from climate sensitive maize dominated towards growing more profitable and climate resilient crops would

support food security, income and women empowerment. Clearly, systems co-design for addressing institutional barriers, comparing priorities and trade-offs under different pathways, supports stakeholder dialogue and policy programming for high intensity and large scale impacts.

Title: **An integrated assessment of climate change impacts and adaptation in maize-based smallholder crop-livestock systems in Kenya**

*Presenter**:** John Antle*

Author: Claessens[1,2,3], S. Gummadi[1], M. Kilavi[4], J. Recha[5], C. Dickson[6], R.O. Valdivia[6], J.M. Antle[6]

Abstract: Climate variability and change are adversely affecting the agricultural sector in SSA and the situation is expected to worsen in future. Smallholder agriculture, the mainstay of the Kenyan economy, is particularly vulnerable and needs to adapt to sustain or improve productivity, food and nutritional security and livelihoods. Addressing adaptation in this context raises challenges calling for an integrated, system-based approach to inform decision and policy making. This paper applies the AgMIP-RIA methodological framework to three agro-ecologies with maize-based smallholder systems across Kenya. We use the TOA-MD model to ex ante simulate impacts of climate change and adaptation with associated economic, environmental and social outcomes in a heterogeneous farm population. Characteristics of current (HH survey) and future agricultural systems are assessed under current and future climate (2050; 5 GCMs x 2 RCPs). Crop and livestock models are used to simulate impacts of climate change and adaptation. Other components of the adapted system are parameterized based on experimental data and/or elaborated from expert/stakeholder consultations. We also apply socio-economic scenarios (Representative Agricultural Pathways) to answer four core questions: (i) Sensitivity of current agricultural systems to climate change? (ii) Benefits of adaptations in current systems? (iii) Impacts of climate change on future systems? (iv) Benefits of adaptations in future systems? The assessment finds that projected climate change negatively impacts current maize-based systems, albeit in heterogeneous ways across agro-ecologies (high-potential zone more maize-reliant, also most vulnerable). Climate impacts on future systems illustrate the importance of examining both bio-physical and socio-economic scenarios. For potential adaptation, in both current and future systems, a majority of farms can benefit from interventions aimed at decreasing fertilizer prices and increasing milk productivity.

***Title*:** **Will South Africa's staple basket run empty by 2050?**

*Presenter**:** Davide Cammarano*

Author: Durand, Wiltrud[1], Crespo, Olivier[2], Fourie, Andries[3], Cammarano, Davide[4], Ngwenya, Hlamalani[5], Mpusaing, Thembeka[6], Tesfhuney, Weldemichael A.[7], Walker, Sue[8]

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Abstract: Food security in South Africa is a multidimensional phenomenon, often difficult to define and understand, is about direct or indirect access to cash to purchase food. Currently 65% of RSA population resides in urban areas due to rapidly urbanisation. The Free State Province produces ±40% of national maize and ±25% of national wheat production under commercial farming practices. These commodities are consumed as staple diet in the form of porridge and bread respectively. Regional Integrated Assessment (RIA) results, following the AgMIP protocol, indicate that under current and future management and future climate, average Free State dryland maize yields will remain at current values except under a Cool-Dry future, being attributed to warming of cool regions. This benefits plant development as maize is not sensitive to a 2°C increase in warm production regions. However, dryland wheat yields under current management and future climate are predicted to be significantly lower. Even under future management systems that include conservation agriculture, this yield reduction will not be offset. Investment into breeding higher yielding, heat and drought tolerant maize and wheat cultivars could however, mitigate climate change. Under current as well as future management and future climate, irrigated maize yields will be lower than current yields, whilst irrigated wheat yields will remain the same. Irrigation as a climate change adaptation mechanism will not be as profitable in future, if management does not change. With increased bread and decreased maize meal consumption accompanying urbanisation, policy makers must formulate a different food security climate change strategy.

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Session 1C: Advances in Simulating Diverse Agricultural Systems

***Title*: Introducing the CROPGRO Perennial Forage Model for Tropical and Temperate Grasses and Legumes**
Presenter: K. J. Boote
Author: K. J. Boote [1], D. N. L. Pequeno [2], P. Alderman [3], S. Rymph [4], M. Lara [5], B. Pedreira [6], W. Malik [7], and L. Moreno [6]
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Abstract: The annual version of the Cropping Systems Model (CSM) CROPGRO was modified and converted to the CSM CROPGRO Perennial Forage model, for the purpose of predicting herbage harvests, herbage protein, and re-growth of perennial forages over multiple seasons. A storage organ (rhizome, taproot, crown) was added as an additional state variable. The model includes seasonal dormancy, freeze thresholds, and rules for

partitioning to the storage organ. Rules for mobilization of carbohydrate and nitrogen from storage pools to drive re-growth and for re-fill of those storage pools were created and added to the species file. This perennial version is released in the latest DSSAT V4.7 software, with adaptations and species files for Marandu brachiaria, Tifton-85 bermudagrass (cynodon), and alfalfa (Medicago sativa). Adaptations are in process for Paspalum notatum, Panicum maximum, napiergrass, and annual ryegrass (Lolium multiflorum). The model requires an additional file called "MOW" that specifies the harvest dates, the residual live stubble and associated percent leaf. The storage pools provide the ability for re-growth despite zero leaf area index caused by harvest or freeze-loss of all leaf tissue, although depletion of reserves from poor management and repeated damage can cause poor recovery and loss of the forage stand. The model will start from seed or vegetative cutting. It uses the DSSAT-CENTURY soil C module for cycling of senesced tissue. Automated harvest routines, prediction of digestibility, and linkages to animal grazing are being developed. Simulated production and re-growth dynamics of brachiaria over 20 harvest cycles over two years will be shown.

***Title*:** **Climate change impacts and vulnerability of farm households in rainfed farming systems of Southern India**

Presenter: Dakshina Murthy Kadiyala

Author: Kadiyala Dakshina Murthy, Swamikannu Nedumaran, Srigiri Srinivasa Reddy, Vellingiri Geethalakshmi, Anthony Whitbread and Sonali P. McDermid ICRISAT, ICRISAT, TNAU, ICRISAT, New York University

Abstract: About 44% of India's food production is from rainfed farming which occupies 57% (80 m ha) of the net cultivated area. The rainfed farming in India is characterized by low productivity, frequent weather variability, policy bias, poor market and infrastructure and degraded natural resources, which leads to low farm income and farm households vulnerability. Along with these challenges, changing climate and socio-economic conditions in the future are a serious threat to the rainfed farming and household profitability. In this study we used the AgMIP Regional Integrated Assessment methodology to assess the potential impacts of climate change on the crop yields, average farm net returns and economic vulnerability of farm households in rainfed farming system in semi-arid region of southern India. We collected and used the socio-economic household survey data in Andhra Pradesh to represent rainfed farming systems, together with down-scaled climate data, site-specific crop model simulations, future representative agriculture pathways (RAPs), and data from global economic model projections. Results indicate that in the study region all the climate models predict a warmer temperatures during mid-century period under RCP 8.5 scenario with an increase from 0.5 to 3°C and rainfall by 6% to 40% across various GCMs. The integrated assessment studies reveals that chickpea yields will decrease in future leaving 67% of current farm households vulnerable and a decrease per capita income by up to 12% in the hot-dry climate models under future climate conditions. Adaptation options were tried under both current and future climate conditions through stakeholder consultation. Adoption of 'climate-smart' package (recommended fertilizer application, critical irrigation and introduction of new rainy season foxtail millet crop) under current conditions, a large percentage of farm

households in fallow-chickpea based cropping systems will move from vulnerable to resilient farm households.

***Title*: Canopy temperature simulation for crop heat stress assessment: physical robustness environments and production conditions**

Presenter: Heidi Webber

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Abstract: Despite widespread application in studying climate change impacts, most crop models ignore complex interactions among air temperature, crop and soil water status, CO2 concentration and atmospheric conditions that influence crop canopy temperature. The current study extended previous studies by evaluating Tc simulations from nine crop models at six locations across environmental and production conditions. Each crop model implemented one of an empirical (EMP), an energy balance assuming neutral stability (EBN) or an energy balance correcting for atmospheric stability conditions (EBSC) approach to simulate Tc. Model performance was evaluated for two experiments in continental North America with various water, nitrogen and CO2 treatments. An empirical model fit to one dataset had the best performance, followed by the EBSC models. Stability conditions explained much of the differences between modeling approaches. More accurate simulation of heat stress will likely require use of energy balance approaches that consider atmospheric stability conditions.

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Session 1D. Climate Change impacts on biophysical systems #1

***Title*:** **Climate change impact on global wheat protein**

Presenter: Senthold Asseng

Author: S. Asseng, P. Martre, A. Maiorano, R.P. Rötter, G.J. O'Leary, G.J. Fitzgerald, C. Girousse, R. Motzo, F. Giunta, M.A. Babar, M.P. Reynolds, A.M.S. Kheir, P.J. Thorburn, K. Waha, A.C. Ruane, P.K. Aggarwal, M. Ahmed, J. Balkovi_, B. Basso, C. Biernath, M. Bindi, D. Cammarano, A.J. Challinor, G. De Sanctis, B. Dumont, E. Eyshi Rezaei, E. Fereres, R. Ferrise, M. Garcia-Vila, S. Gayler, Y. Gao, H. Horan, G. Hoogenboom, R.C. Izaurralde, M. Jabloun, C.D. Jones, B.T. Kassie, K.C. Kersebaum, C. Klein, A.K. Koehler, B. Liu, S. Minoli, M. Montesino San Martin, C. Müller, S. Naresh Kumar, C. Nendel, J.E. Olesen, T. Palosuo, J.R. Porter, E. Priesack, D. Ripoche, M.A. Semenov, C. Stöckle, P. Stratonovitch, T. Streck, I. Supit, F. Tao, M. Van der Velde, D. Wallach, E. Wang, H. Webber, J. Wolf, L. Xiao, Z. Zhang, Z. Zhao, Y. Zhu and F. Ewert

Abstract: Supplying an increasing amount of wheat grains and protein will be a challenge with future climate change. Some climate change factors favor yield but reduce protein content in grains and vice versa. AgMIP-Wheat found across representative wheat growing locations of the world a wide range of yield and protein responses. Warmer regions will likely lose yield, while in temperate regions, yield loss from increasing temperatures could be partly compensated through elevated atmospheric CO2 concentrations. Grain protein content will mostly decline with future climate change. These trends will be accelerated through adaptations, if these focus on yield only.

***Title*:** **European winter oilseed rate production under climate change**

Presenter: Johannes W.M. Pullens

Author: Pullens, Johannes Wilhelmus Maria[1]; Sharif, Behzad[1]; Trnka, Miroslav[2,3]; Olesen, Jørgen Eivind[1]

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Abstract: In Europe winter oilseed rape (Brassica napus L., WOSR) is mainly grown for biofuel and edible oil production and is Europe's premium oilseed crop. Currently WOSR is grown widespread in Europe, where the majority of the production areas are located in Germany, Poland, Lithuania, Latvia and France. A phenology model based on the BRASNAP-PH phenology model of Habekotté (1997) is used to understand how climate change will affect the location where WOSR in Europe can be grown. The model was cross-calibrated on data from variety trials of 12 sites in Czech Republic (1990-2012) and wrapped into the AgriClim model, to run the model for 14 sites distributed over Europe with different climate scenarios. In total 11 agroclimatic indices were calculated, reflecting non-optimal agroclimatic growing conditions with respect to physical and biological stressors. Two of these agriclimatic indices are the two main diseases is incorporated (Phoma stem canker and light leaf spot). Based on the model runs with

climate scenarios, the Northern regions (Boreal environmental zone) of Europe will become more in favour of growing WOSR in comparison to the Southern regions of Europe, where the temperature will become too high. The increase in temperature in the Northern regions (Boreal zone) of Europe results in shorter growing seasons and will make WOSR therefore a suitable crop to grow more often.

***Title*: Adjusting Climate Model Bias for Agricultural Impact Assessment: the BAD-JAM project**

Presenter: Stefano Galmarini

Author: S. Galmarini, A.J. Cannon, A. Ceglar, O.B. Christensen, N. de Noblet-Ducoudré, F. Dentener, F. J. Doblas-Reyes, A. Dosio, J. M. Gutierrez, H. Loukos, A. Maiorano, D. Maraun, S. Mcginnis, G. Nikulin, A. Riccio, E. Sanchez, E. Solazzo, A. Toreti, M. Vrac, M. Zampieri

Abstract: The BAD-JAM (Bias ADJustment for Agricultural Models) will be presented. The project foresees that a community of climate modellers will use state-of-the-art B-A methods to produce time series from 1980 to 2100 of EURO-Cordex agro-relevant climate data at specific locations.

We propose the AgMip wheat crop modelling community to use the data to produce wheat-yield projections which will be compared and critically analyzed in the light of the B-A technique used and the difference in the climate data used. The EC/JRC is leading the project, details on the project workings will be presented.

***Title*: Climate change impact on Mexico wheat production**

Presenter: Diego Pequeno

Author: Pequeno, Diego Notelo Luz[1], Hernandez-Ochoa, Ixchel M.[2], Asseng, Senthold[2], Kassie, Belay T.[23], Xiong, Wei[24], Robertson, Ricky[5], Sonder, Kai1, Reynolds,Matthew[1], Babar, Md Ali[6], Milan, Ana Isabel Molero[1], Hoogenboom, Gerrit[7]

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Abstract: Wheat is one of the most important cereal crops in Mexico, but the impact of future climate change on production is not known. To quantify the impact of future climate change together with its uncertainty, two wheat crop models were executed in parallel, using two scaling methods, five Global Climate Models (GCMs) and two main Representative Concentration Pathways (RCPs) for the 2050s. Simulated outputs varied among crop models, scaling methods, GCMs, and main RCPs; however, they all

projected a general decline in wheat yields by the 2050s. Despite the growth-stimulating effect of elevated CO2 concentrations, consistent yield declines were simulated across most of the main wheat growing regions of Mexico due to the projected increase in temperature. Exceptions occurred in some cooler areas, where temperature increases improved sub-optimal conditions, and in a few areas where rainfall increased. Larger and more variable yield declines were projected for rainfed wheat due to current and projected spatial variability of temperature and rainfall patterns. When aggregating the simulated climate change impacts, national wheat production for Mexico is projected to decline between 6.1% for RCP 4.5 and 6.5% for RCP 8.5. Model uncertainty in simulated yield changes, and across two scaling methods, is smaller than temporal and spatial variability in both RCPs. Spatial variability tends to be the largest in both future scenarios. To maintain or increase future wheat production in Mexico, adaptation, particularly to increasing temperatures affecting irrigated wheat, or expanding the cropping area, will be necessary.

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Session 2A: Resolving Crop Losses (including Pests, Diseases, Weeds, Ozone)

***Title*:** **Toward a regional early warning system network for coffee leaf rust and associated socio-economic crises**

Presenter: Jacques Avelino
Author: Avelino, Jacques [1,2,3], Allinne, Clémentine [1,2], Bommel, Pierre [1], Cofre, Hipólito [2], De Melo, Elías [2], Casanoves, Fernando [2], Gamboa, Harold [3], Gutiérrez,Isabel [2], Leclerc, Grégoire [1,2], Merle, Isabelle [1], Motisi, Natacha [1], Ribeyre, Fabienne [1], Sibelet, Nicole [1], Tixier, Philippe [1], Treminio, Edwin [2]
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Abstract: Coffee rust epidemics that occurred in Latin America since 2008 have caused millions of dollars losses, job losses, and food security issues. In response to this crisis, Central American and Caribbean countries have been developing national surveillance systems to prevent future coffee rust epidemics.
The European Union is supporting these initiatives through the PROCAGICA project led by IICA, which aims at increasing the national and regional capacity to prevent coffee rust and the resultant socio-economic crises. Indeed, pest and disease risk warnings and management recommendations may not be followed by producers' actions, meaning that outbreaks will impact producers' livelihoods. Responses must therefore also encompass the economic sphere. In addition, the project aims at promoting the establishment of a regional coordination to enable the exchange of information on epidemic risks between countries, as pests and pathogens can spread over large distances.
The Central American early warning system network is based on harmonized national early warning systems coupling surveillance and monitoring, with expert knowledge and forecast models. The estimated risks of epidemic and socioeconomic crises will lead to actions specific to each country. The system will help launching general warnings and personalized recommendations to farmers.

In this presentation we evaluate a range of modelling approaches for forecasting coffee rust and socio-economic crises associated to rust outbreaks, including Structured Equations Modelling of coffee rust, multi-criteria models, machine learning, agent based models and Bayesian models.

***Title*: Air Quality and Agriculture – Critical pollutants, risk assessment and response.**

Presenter: Lisa Emberson

Author: Emberson, L.D[1]., Pandey, D[1]., Dentener, F[2]., van den Berg, M[2]., Maiorano, A[2]., Ewert, F[3,4].

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Abstract: There are a number of air pollutants that are well known to alter agricultural yields. This paper identifies which of these air pollutants might be considered 'critical' for agriculture through understanding both the magnitude and spatial extent over which effects occur.

We describe what is known of the mechanisms by which these pollutants influence crop productivity (e.g. ozone is a phyto-toxic pollutant that acts directly on uptake via the stomates whilst particulate matter largely acts indirectly to alter yield through modification of incoming solar radiation). We review and evaluate the ability of existing models (including risk assessment models, crop models and land surface exchange schemes) to simulate, at regional to global scales, the influence of air quality on arable crops.

We discuss various mitigation and adaptation options in the context of climate change since many air pollutants are also climate forcers which impact near term climate and weather patterns. Mitigation options include reducing emissions from agriculture (e.g. agricultural residue burning and controlling soil erosion) as well as emissions from fossil fuel burning associated with urban and industrial centres. Adaptation options include modifying agricultural practices which would reduce the influence of air quality on crops and enhance crop resilience to air pollution and other stresses.

Finally, we describe the ambition of the AgMIP-ozone group and how the approach used within this activity could be extended to incorporate additional 'critical' air pollutants and develop a programme of work within AgMIP to enable a more holistic assessment of these abiotic stressors on agriculture.

***Title*: Modelling the effects of multiple diseases on wheat growth and yield**

Presenter: Kurt Christian Kersebaum

Author: Kersebaum, Kurt Christian[1], Willocquet, Laetitia[2], Savary, Serge[2,] Rossi, Vittorio[3], Olesen, Jørgen E.[4], Bregaglio, Simone[5], Feike, Til[6], Ferrise, Robert[7], Bindi, Marco[7], Asseng, Senthold[8], Hoogenboom, Gerrit[8], Pavan, Willingthon[8], Stella, Tommaso[1], Ficke,

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[10] Swedish University of Agricultural Sciences, Uppsala, Sweden
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Abstract: Modelling the effects of plant diseases and pests on crop performance and yield is an important new challenge AgMIP and MACSUR want to address. The PeDiMIP (pest and disease modelling inter-comparison project) group of AgMIP, and the "Pest and Disease" group within MACSUR address this question. We report here progress in our work on wheat health. In a first step, five wheat growth models of differing complexity implemented generic damage mechanisms associated with four foliar diseases: septoria tritici blotch, leaf (brown) rust, stripe (yellow) rust, and powdery mildew. Using a reference data set from Denmark, field data of a "pest-free" treatment was first used for crop model calibration, and for modelling wheat growth and yield in absence of disease. Idealised (temporal) patterns of disease injuries represented by simplified disease progress curves were then used as drivers to simulate the effects of individual and combined diseases on wheat growth and yield. In a second step, field data from the reference (experimental) data set of non-protected field plots together with observed disease severity data was used to test simulations of disease effects on biomass, leaf area and crop yield loss against observed data affect by septoria tritici blotch and powdery mildew. We are currently collecting data on disease spread, intensity, disease impact and crop yield loss from a range of experiments different countries to take a third step to estimate yield losses caused by individual and combined wheat diseases in several European countries.

***Title*: Identification of microclimatic variables determining the appearance of the symptoms of a leaf disease: case of the coffee leaf rust**

Presenter: Merle Isabelle
Author: Merle Isabelle[1], Tixier Philippe[2], Cilas Christian[1], Avelino Jacques[1]
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Abstract: Coffee leaf rust (Hemileia vastatrix) caused major epidemics since 2012 in Central America. In order to prevent future epidemics, PROCAGICA program (Programa Centroamericano de Gestión Integral de la Roya del Café) aims to the creation of a warning system with an epidemic forecast component based on meteorological variables. Currently, recommendations to control this disease are based on costly treatment schedules. We hypothesize that it is possible to predict the outbreaks of coffee leaf rust

and that dynamic of epidemics is the result of complex combinations of microclimatic variables acting at different times (times and durations). Our goal is to build three models: appearance of infections, first produced spores, intensification of sporulation. For this purpose, a trial was set up in Costa Rica in three sites at different altitudes and under different oceanic influences in order to cover important fluctuations of the mesoclimate. The microclimate is measured continuously using weather stations and a weekly monitoring of rust lesions is performed to know the dates of onset of the different symptoms corresponding to different stages of development of the epidemic. Preliminary results on the microclimate variables (nature and timing) that determine the onset of first symptom (emergence of non-sporulating lesions) will be presented and discussed.

***Title*: Crop diseases and pests: from crop losses to biocomplexity**

Presenter: Kersebaum, Kurt Christian

Author: S. Savary, INRA France, P. D. Esker PennState, USA, N. McRoberts UCDavis, USA, L. Willocquet, INRA France, K. C. Kersebaum, ZALF Germany, S. Asseng U. Florida, USA, W. Pavan, U. Passo Fundo, Brazil, R. Ferrise, U. of Florence, Italy, R. Magarey, North Carolina State U. USA, M. Donatelli, CREA Italy, S. Bregaglio, CREA Italy.

Abstract: PeDiMIP, the pest and disease modeling intercomparison project, participated in the International Conference on Global Crop Losses organized in Paris in October 2017, where participants from some 20 countries addressed the effects and modeling of crop losses. Progress is also underway at several centers in Europe and the USA in the intercomparison of several Wheat crop models augmented with dynamic damage mechanisms for an array of diseases, insects and weeds. Diseases and pests are integral part of world's crop systems, and are critical elements to understand, model, and manage sustainable farming systems. These systems – their design, development, management, and their disruption or sustainability – involve human beings – farmers, policymakers, consumers – to a very high degree. A next frontier in the modeling of crop diseases and pests therefore involves addressing the biocomplexity of human-managed systems. While the Wheat - Multiple Pest system exemplifies biocomplexity in annual crops, the Coffee-Rust system is an excellent and key example of biocomplexity in perennials. Simulation outputs illustrate the annual oscillations of coffee yields, the negative effect of rust intensity on yield, and the positive feed-back of attainable yield on rust intensity. Simulation modeling enables understanding why rust exacerbates variation in coffee yield, how fungicides may reduce losses, and why shade trees dampen dangerous annual oscillations in yield and disease, while enhancing ecosystem services. Modeling biocomplexity in [human - crop - diseases and pests] systems is a critical challenge for sustainable farming systems modeling, as well as for the development of next generation models and tools.

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Session 2B: Advanced Computational Applications for Agriculture

***Title*: The Agricultural Model Exchange Initiative**

Presenter: Pierre Martre

Author: Martre Pierre[1], Donatelli Marcello[2], Pradal Christophe[3], Enders Andreas[4], Ahmed Midingoyi Cyrille[1], Athanasiadis Ioannis[5], Fumagalli Davide[6], Holzworth Dean[7], Hoogenboom Gerrit[8], Porter Cheryl[9], Raynal Hélène[10], Rizzoli Andrea[11], Thorburn Peter[12]

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[9] Agricultural & Biological Engineering, University of Florida, Gainesville,

Abstract: Process-based crop simulation models are increasingly popular tools to analysis and predict the response of agricultural systems to climatic, agronomic and, more recently genetic, factors. The diversity of models in use illustrates the success of crop modeling. For instance, in it is current work the AgMIP Wheat team uses 42 different wheat models. Several groups in AgMIP have reported large uncertainty in climate impact studies, which is calling for more systematic model intercomparisons and improvements at the process level. However, the limited possibilities of model components (algorithms) and code exchange between platforms/models hinders such work. Collaborative efforts between crop physiologists, crop modelers, and software engineers are urgently needed to ease the integration in crop models of new knowledge in plant and soil sciences. To this end, several leading groups in the field have recently liaised to form the Agricultural Model Exchange Initiative (AMEI). AMEI is an open initiative that aims to address different challenges for exchanging model units at different granularities (from individual processes to whole plant) between modeling frameworks by (1) defining standards to describe model units and composition exchange format based on a declarative representation; (2) including unit tests with invariants and shared standard parametrizations; and (3) developing a web-platform to publish, document, and exchange the model units. We will provide a conceptual and technical overview of the state of the work and give practical examples of successful component exchange between different frameworks.

***Title*:** **Making messy socio-economic data FAIR**

Presenter: Gideon Kruseman

Author: Kruseman, Gideon[1], Kim, Soonho[2], Van Wijk, Mark[3]

[1] International Maize and Wheat Improvement Center (CIMMYT)

[2] International Food Policy Research Institute (IFPRI)

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Abstract: Managing shared data is becoming increasingly important as we move towards an open data world. For sharable data to be actionable, it needs to be FAIR: findable, accessible, interoperable and re-usable. In applied interdisciplinary research, data from many different sources are used. Socio-economic data is often referred to as being of relatively low quality. In part, this is due to a lack of standardization. Socio-economic data is messy. Data sets tend to be a mix of structured semi-structured, and unstructured data. The community of practice on socio-economic data (#CoP_SED) , which is part of the CGIAR Platform for Big Data in Agriculture aims at providing the tools to make socio-economic data FAIR. In this presentation, we will address some of the latest developments in managing actionable open data, touching on issues such as ontologies, metadata schemas, key indicators, data curation and confidentiality. This is ongoing work, which has the potential of revolutionizing the way we use socio-economic data.

***Title*:** **Shared protocols and data template in agronomic trials**

Presenter: Davide Cammarano

Author: Cammarano, Davide[1], Drexler, Dora[2], Martre, Pierre[3], Cooper, Julia[4], Drayer, Xavier[5], Helga, Willer[6], Pecchioni, Nicola[7], Sessitch, Angela[8], Voicu, Adriana[3], Hinsinger, Philippe[3]

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[8] Austrian Institute of Technology (AIT)

Abstract: The aim of the study is to show how a H2020-Funded project is proposing to tackle the issue of data standardization and shared protocols among 25 partners. The project SolACE (Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use) is proposing to create a common data dictionary for all the data-collection activities among partners. The data dictionary contains the header of the variables, the units in which will be reported, and the definition. An existing data dictionary (ICASA Data Standard) has been used as baseline. But, additional variables can be added if they are not in the dictionary. In addition, a common set of templates has been created and shared among partners so that all the agronomic trials will be reported in a same "text-delimited" file. Its structure is flexible because it should allow users to add only the variable they measure in the field. But, if they are reported according to our dictionary it will facilitate data analysis and the creation of tools that will help to visualize data. Finally, a "living" handbook of protocols is shared among partners with the aim of clearly report what steps and methodology have been taken in order to collect the data.

***Title*: AgMIP Data Interoperability: Moving beyondRegional Integrated Assessments**

Presenter: Cheryl Porter

Author: Martre Porter, Cheryl[1], Villalobos, Chris[2], White, Jeff[3], Hoogenboom, Gerrit[4], Devare, Medha[5]

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[5] CGIAR Consortium

Abstract: AgMIP promotes comparisons among cropping system models through use of common datasets. Interoperability tools were developed to allow multiple crop models to access consistent input data and to harmonize model outputs regardless of internal model requirements. AgMIP use cases for data interoperability tools include the DFID-fundedRegional Integrated Assessments activities in Sub-Saharan Africa and South Asia, the wheat model intercomparison activities, and the PSIMs gridded modeling framework. The AgMIP data interoperability tools are increasingly being used by non-AgMIP researchers, who recognize the need for harmonizing agricultural data from diverse sources for use in quantitative analyses. Applications include CGIAR CCAFS Regional Agricultural Forecast Tool (CRAFT), S-World global soil mapping software, DOE Terra project, and direct use as input to crop models. Additionally, the ICASA Data Dictionary has been aligned with the CGIAR Crop and Agronomy ontologies to facilitate the future use of semantic technologies for discovery and access of data relevant to modeling and other quantitative analyses.

We have found that it is difficult to balance the use of scarce resources to solve the immediate needs of users for data curation and interoperability tools versus dealing with longer-term development of robust frameworks based on ontologies and semantic technologies for data discovery and access. The AgMIP community of users shared an immediate demand for data interoperability tools, which was most readily satisfied by building on the existing ICASA Data Dictionary. The existing system is flexible, efficient, extensible, and forms a solid foundation for next generation data interoperability systems.

***Title*: Mobile phone based advisories for smallholder farmers; lessons from the field**

Presenter: Peter Craufurd

Author: Craufurd, Peter[1] and Andersson, Jens[1]

[1] CIMMYT

Abstract: The use of Information and communications technologies (ICT) for knowledge sharing, and especially advice via decision-support tools (DST) on mobile devices, is frequently proposed as a means to improve small-holder farming. Mobile phones are also a potentially useful source of spatial and temporal data on variables that are hard to collect remotely, such as yield and prices, i.e.crowd-sourcing. In TAMASA (Taking Maize Agronomy to Scale in Africa) we have been evaluating, with a range of different users, mobile-phone based decision support tools for maize crop. Stakeholders, both individuals and more importantly service providers, commonly demand information on weather (when to plant, risk of drought), fertiliser use (what type, rate and timing),

variety selection, and pest and disease advisories. We also observe that most smallholder maize farmers do not plant or achieve anywhere near optimal plant population densities. We have therefore been co-developing and evaluating with users DSTs for nutrient management, variety selection, planting date, and seed rate/ plant population density. This presentation will share many of the lessons we have learnt and question whether this is the panacea many believe. Key lessons include: the absolute importance of the user-interface (UI) and the experience for the user; enabling advice to be actioned; and institutionalisation of the app and background analytics.

***Title*: Evolving the AgMIP Impacts Explorer**

Presenter: Sander Janssen

Author: Sander Janssen, Alex Ruane, Roberto Valdivia, Senthold Asseng, John Antle, Cheryl Porter, Carolyn Mutter, Joske Hootkamp

Abstract: The AgMIP Impacts Explorer is a web-based tool, developed to make the outcomes of AgMIP Phase 2 regional studies accessible for use in policy and research. The Impacts Explorer allows a variety of audiences to explore future projections of risk and vulnerabilities in the agricultural sector, implications of food security, and adaptation options, through three components: (1) a descriptive overview of main outcomes of the regional studies; (2) a dashboard with infographics of key findings for comparing results across regions and systems; and (3) an interactive Data Exploration Tool, providing access to model outputs and economic evaluations underlying the analysis. Because of the modular design and the utility of the components, the Impacts Explorer can be extended to include results of other research projects, offering an easy to use platform for dissemination. Moreover, the tool makes results comparable along different dimensions such as regions or farming systems, substantially augmenting the value of the individual studies. This paper presents use cases illustrating this potential of the Impacts Explorer; and discusses possible modifications of the platform, and data requirements for participating projects.

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Session 2C: Data Assimilation and Seasonal Forecasting of Agricultural Shocks

***Title*: Crop Yield Predictions - Multi-scale Statistical Model for Intra-season Forecasts Applied to Corn in the US**

Presenter: Yiqing Cai

Author: Cai, Yiqing [1], Moore, Kristen [1], Pellegrini, Adam [1], Elhaddad, Aymn [1], Lessel Jerrod [1], Townsend Christianna [1], Solak Hayley [1], Zhao Yi [1], Semret, Nemo [1],
[1] Gro Intelligence, Inc

Abstract: Accurately forecasting crop yields has broad implications for economic trading, food production monitoring, and global food security. However, the lack of highly accurate environmental measurements makes it difficult to capture the variation of yield across space and time.

To maximize the information gain from the available data, we developed a sequence of hierarchical machine-learning based models accurately forecasting end-of-season corn

yields for the US at both the county and national levels, including in very anomalous seasons. Furthermore, we incorporated crop physiological processes in our model's feature selection. Our model has run live since 2016. In 2017, our forecast was in the correct direction (above trend) ahead of the market and USDA's forecast since mid August, and was already within 2% of the USDA January forecast since mid September. In the backtesting of the 2000-2016 period, our model predicts national yield within 2.55% of the actual yield on average already by mid-August. At the county level, our model predicts 80% of the variation in final yield by the beginning of October, with 77% counties predicted within 10% of the average yield. Further, the most significant producing regions had the lowest error rates, resulting in our high precision national-level forecasts.

In addition, we identify the changes of important variables throughout the season, specifically early-season land surface temperature, and mid-season land surface temperature and vegetation index.

As the first example of Gro yield model framework, this can be extended to other crops and regions with consistent performance evaluation.

***Title*: The Agricultural Productivity Indicator Analysis System (APIAS)**

Presenter: Meridel Phillips

Author: Ruane, Alex [1], Phillips, Meridel [2], Elliott, Joshua [3]

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[2] Columbia University Center for Climate Systems Research

[3] University of Chicago

Abstract: We present the Agricultural Productivity Analysis and Indicator System (APIAS), which is designed to create a set of indicators regarding the current and future response of agricultural lands in the United States to climate changes and shifts in climate extremes. We utilize a configuration of the pDSSAT crop model for maize, wheat, and soy under rainfed and irrigated conditions and then apply a series of historical data, sensitivity tests, and future scenarios. Preliminary work shows strong correlation with observed yield statistics, and a comparison with the AgMIP Global Gridded Crop Model Intercomparison reveals a substantial spread in models but also strong performance by the ensemble mean. Our analysis of APIAS sensitivity tests helps us establish critical temperature and precipitation thresholds for specific levels of mean yield loss and increases in yield variability at both constant and elevated CO2 levels. We conclude with a discussion of future plans, including the rapid emulation of impacts from new scenarios, the development methods to integrate with the assimilation of remotely-sensed data, seasonal yield forecasting, and counterfactual analysis of extreme events in recent decades.

***Title*: Crop and crop management identification from space for national-scale modelling**

Presenter: Claas Nendel

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Abstract: Recent increase in quality and quantity of high-resolution optical remote sensing data, agricultural mapping applications now enables satellite-borne analyses to identify land use rather than land cover only. The European Sentinel-2 twin platform constellation provides unprecedented observation frequency at high resolution, new spectral bands and improved spatial resolution. Nevertheless, cloud cover can still render large parts of the growing season to remain unobserved. Integrating additional observations of similar nature, such as those of the Landsat mission, can further improve observation frequency. We processed all available imagery over a time period of 15 months that was acquired by Sentinel-2a Multispectral Imager (MSI) and Landsat-8 OLI over Germany and integrated observations into composites. Our processing approach includes generating proxy values for Landsat OLI in the Sentinel-2 MSI red edge bands and temporal gap filling on the 10-day time-series. We then derived a national scale crop type and land cover map based on machine learning models. These models were parameterized using reference data from the Land Parcel Information System (LPIS), which was available for three federal German states. Grassland use intensity was determined using a polynomial fit to the vegetation index time series. Informed by frequently assimilated variables for crop growth and development, such as leaf area index, evapotranspiration, crop nitrogen and turgor status, as well as radar-derived information on sowing and harvest dates (Sentinel-1), national-scale simulations for nitrogen leaching and greenhouse gas emissions will be produced on a High Performance Computing Facility.

***Title*: EOFSAC: A Multidisciplinary Consortium to Enhance Food Security and Agriculture through Earth Observations**

Presenter: Roberto Cesar Izaurralde
Author: Becker-Reshef, Inbal[1], Bandaru, Varaprasad[1], Whitcraft, Alyssa[1], Izaurralde, Roberto[1]
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Abstract: This presentation will describe the Earth Observations for Food Security and Agriculture Consortium (EOFSAC), a multidisciplinary program commissioned by NASA and led by the University of Maryland to enhance the use of satellite data in domestic and global decision making related to food security and agriculture. EOFSAC seeks to contribute toward increased food security and resiliency, reduced price volatility and vulnerability, and improved awareness and understanding of the applications of NASA's and other satellite data products by users from a wide range of sectors including researchers, aid organizations, economists, policymakers, agribusiness, finance, defense, intelligence, and technology. Details of EOFSAC's organization, partners, and activities will be presented including an early example of the development of a satellite-based crop growth and yield forecasting system.

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Session 2D: Regional Assessments of biophysical and economic systems #2

***Title*: Assessing adaptation costs in irrigated agriculture integrating hydrological and crop simulation models: case study from central Chile**

Presenter: Francisco Meza
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Abstract: Adapting agriculture to climate change is one of the most important challenges that our society will have to face in the next decades. However there are still many fundamental questions that have to be answered to ensure an effective use of resources and avoid maladaptation practices. One of them corresponds to the assessment of costs/benefit ratio of adaptation options and its comparison against a no adaptation case.

In spite of the relevance of such information for policy and decision making, literature does not show a large number of documented case studies that address this issue. This paper shows a methodology to assess adaptation cost of multiple generalized alternatives and its comparison against yield loses that will be observed if a no-adaptation decision is made.

Methods: A simplified methodology based on results obtained from a calibrated hydrological and crop simulation model (WEAP and PGM respectively) has been implemented. Climate change scenarios are defined as a combination of changes in temperature and precipitation. The model is run for each scenario to obtain yield loses and water demand and availability as function of climate in two different basins of central Chile.

A set of adaptation options derived from the National Adaptation Plan for the Agricultural sector were classified and evaluated in their ability to contribute to satisfy new water demands and reduce yield penalizations. An optimization algorithm was implemented to select alternatives that minimize cost subject to the satisfaction of water demands.

Results show that, regardless of the adaptation measure, the cost of adaptation is smaller than the cost of no adaptation. For less severe climate change scenarios, adaptation options based on improving Water Management practices produce better results than investing in infrastructure, especially if water use efficiency is relatively low.

***Title*: Rice-Wheat farming in the Indo-Gangetic Plains in the 2050s: Can Sustainable Agricultural Pathways offset Climate Change Vulnerabilities?**

Presenter: N. Subash
Author: N. Subash[1], *, Harbir Singh[2], Balwinder Singh[3], Gokul Paudel[4], M.S. Meena[5], Sohan Vir Singh[6], Guillermo Baigorria[7], Roberto Valdivia[8] and Carolyn Mutter[9]
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Abstract: Indo Gangetic Plains (IGP), the cereal basket of South Asia (SA), is facing a serious problem of decline/stagnation in productivity due to over exploitation of natural resources with rapid population growth and industrialization. Climate change and climate variability impacts are increasingly visible in SA, with greater variability of the monsoon. Under AgMIP-ICAR Collaborative Project, we have tried to link the climate-crop-socio economic models for integrated assessment of climate change impact on agricultural productivity using AgMIP-protocol in two study districts of IGP viz., Meerut and Karnal districts. Rice-wheat is the predominated cropping system in these study area. The survey data of each study districts showed that there is lot of variability between the districts, in terms of household size, income (both off- farm and on-farm, livestock population etc). It is noticed that there is lot of different in projected net farm income in these two districts in 2050s under sustainable pathway. There will be small reduction in mean net farm income of the order of -0.8 % in Meerut district, while 13.5 % increase in Karnal district. This may be due to higher contribution of livestock component in future production system. It is found that 52 % of the farms will be vulnerable in Meerut while 35 % of the farms vulnerable in Karnal district under sustainable green road pathways (moderate emission) in 2050s. The study underlined the need for such integrated assessment throughout India because of diverse farming system exists under 127 agro-climatological zones of the country.

***Title*: Climate change impacts and vulnerability of fallow-chickpea based farm households in India: Assessment using Integrated modeling approach**

Presenter: Dakshina Murthy Kadiyala
Author: Nedumaran S[1], Kadiyala Dakshina Murthya[1], Srinivasa Reddy Srigiri[2], Roberto O Valdivia[3] and Sonali McDermid[4]
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Abstract: The rainfed farming in India is characterized by low productivity, frequent weather variability, policy bias, poor market and infrastructure and degraded natural resources, which leads to low farm income and farm households vulnerability. Along with these challenges, changing climate and socio-economic conditions in the future are a serious threat to the rainfed farming and household farm profitability. In this paper we use the AgMIP Regional Integrated Assessment (RIA) methods which integrates climate, crop and economic modeling to assess potential impacts of climate change on the economic vulnerability of farm households, average farm net returns and poverty rate in semi-arid region of Andhra Pradesh, India. This study used the socio-economic data from representative household survey which represent chickpea-based rainfed farming systems, together with down-scaled climate data, site-specific crop model simulations.

The simulation results shows that the majority of fallow-chickpea based farm households are vulnerable (68% in warmer climate and 42% in wet climate) to climate change if current production systems are used in the future. Vulnerability is not uniform across the Kurnool district and climate impacts vary across climate scenarios. Therefore, development and promotion of location specific adaptation strategies linking technologies, policies and infrastructure is need to improve the resilience and adaptive capacity of farm rainfed farm households to climate change.

***Title*: Impacts of 1.5 versus 2.0°C on West African cereal yields**

Presenter: Heidi Webber

Author: Faye, Babacar[1], Webber, Heidi[2], Naab, Jesse[3], MacCarthy, Dilys[4], Adam, Myriam[5,6,7], Ewert, Frank [1,2], Lamers, John[8], Schleussner, Carl-Friedrich[9,10], Ruane, Alex[11], Gessner,Ursula[12], Hoogenboom,Gerrit[13], Boote, Ken[13], Shelia, Vakhtang[13], Saeed, Fahad[9], Wisser, Dominik[14], Hadir, Sofia[1], Laux, Patrick[15], Gaiser, Thomas[1]

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Abstract: With the Paris Agreement, governments around the world agreed to limit global temperature rise to less than 2.0°C above pre-industrial levels, with the ambition to keep warming to 1.5°C. Designing appropriate mitigation responses requires weighing costs of mitigating versus associated damages for the two levels of warming, with particular consideration of the implications for regions already challenged by food insecurity. This study assessed impacts in the West African Sudan Savanna of 1.5°C versus 2.0°C on yields of maize, pearl millet and sorghum. Two crop models were used that were calibrated with common varieties from experiments in the region. To capture a range of realistic management, early, typical and late sowing was assessed. Further, simulations were conducted for both current fertilizer rates and for an intensification case which assumed fertility not limiting, in attempt to capture the extremes of possible economic development scenarios on current cropping systems. With current fertilizer use, results indicated 2% units higher losses for maize and sorghum with 2.0°C compared to 1.5°C warming, with no change in millet yields for either scenario. In the intensification case, yield losses due to climate change were larger than with current fertilizer levels. However, despite the larger losses, yields were always 2-3 times higher with

intensification, irrespective of the warming scenario. Though yield variability increased with intensification, there was no interaction with warming scenario. Risk and market analysis are needed to extend these results to understand implications for food security.

***Title*: Climate change impacts on current and future agricultural systems in the semi-arid regions of West Africa**

Presenter: Ibrahima Hathie

Author: Ibrahima Hathie[1], Dilys S. MacCarthy[2], Roberto Valdivia[3], John Antle[3], Myriam Adam[4], Samuel K. Adiku[5]

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Abstract: Agriculture in the semi-arid regions of West Africa is mainly rain-fed with a large number of smallholder farmers dependent on it for their livelihoods. Farming systems are dominated by cereals and legumes with livestock playing a significant role in the functioning of the systems. In this paper, we use the AgMIP Regional Integrated Assessment methods, which include a set of mid-century climate projections, biophysical (Decision Support Systems for Agro-technological Transfer; DSSAT and Agricultural Production Systems sIMulator; APSIM) and economic (trade-off analysis model: TOA-MD) models, representative agricultural pathways and global economic model projections to explore the impacts of climate change on the economic vulnerability of farm households in Nioro, Senegal. Our results indicate that most climate scenarios - except the hot-dry had positive impacts on peanuts which is one of the main crops in this production system. The effect of climate change on maize was negative and the impacts on millet were variable but changes are small. In tomorrow's production systems and socio-economic conditions, climate change would have positive impact on Nioro farmers livelihoods in almost all cases simulated. However, with low prices, climate change would have a negative impact of Nioro farmers' livelihoods in most cases. For Senegal, these results have significant policy implications, in particular on international trade and regional prices as peanut is one of the major export commodities.

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Session 2E: Modeling the Causes and Cascading Impacts of Food Shocks

***Title*: New crop modelling technique for improving model performance under climate change and stress simulations**

Presenter: Ioannis Droutsas

Author: Droutsas, Ioannis[1], Challinor, Andrew[1], Semenov, Mikhail[2]

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Abstract: Increased climate variability under global warming brings a higher frequency of extreme weather events and more complex environmental interactions which can damage crops and limit their final yield. Modelling the impact of these extreme events on crops can be difficult due to the complexity of the processes involved. As a result, models often show a variable skill in the simulation of plant performance under stress conditions. At the same time, models often suffer from a lack of internal consistency due to discretisation of time and the difficulty of setting initial conditions. We hypothesised that improving this internal consistency whilst decreasing parameterisation requirements would improve model skill. Accordingly, we present a new dynamic crop modelling method for simulating the impact of abiotic stresses on crop growth and development. The new method is based on a simultaneous solution of the model equations instead of the prevailing step-by-step method used in most crop models. It is called SEMA (Simultaneous Equation Modelling Approach) and it is implemented here in the GLAM crop model. The new model version is called GLAM-PARTI and it is mainly developed for climate change impact studies. GLAM and GLAM-PARTI are tested here under different levels of water stress and the new model shows a clear improvement in skill in all water limited conditions. Based on previous model simulations of the same experiment we conclude that SEMA is a promising technique and we list some potential applications.

***Title*: Contribution of crop model structure, parameters and climate projections to uncertainty in climate change impact assessments**

Presenter: Fulu Tao

Author: Fulu Tao[1],*, Reimund P. Rötter[2,3], Taru Palosuo[1], Carlos Gregorio Hernández Díaz-Ambrona[4], M. Inés Mínguez[4], Mikhail A. Semenov[5], Kurt Christian Kersebaum[6], Claas Nendel[6], Xenia Specka[6], Holger Hoffmann[7], Frank Ewert[6,7], Anaelle Dambreville[8], Pierre Martre[8], Lucía Rodríguez[4], Margarita Ruiz-Ramos[4], Thomas Gaiser[7], Jukka G. Höhn[1], Tapio Salo[1], Roberto Ferrise[9], Marco Bindi[9], Davide Cammarano[10] and Alan H. Schulman[1,11]

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Abstract: Climate change impact assessments are plagued with uncertainties from many sources, such as climate projections or the inadequacies in structure and parameters of the impact model. Previous studies tried to account for the uncertainty from one or two of these. Here, we developed a triple-ensemble probabilistic assessment using seven crop models, multiple sets of model parameters and eight contrasting climate projections together to comprehensively account for uncertainties from these three important sources. We demonstrated the approach in assessing climate change impact on barley growth and yield at Jokioinen, Finland in the Boreal climatic zone and Lleida, Spain in the Mediterranean climatic zone, for the 2050s. We further quantified and compared the contribution of crop model structure, crop model parameters and climate projections to the total variance of ensemble output using Analysis of Variance (ANOVA). Based on the triple-ensemble probabilistic assessment, the median of simulated yield change was _4% and +16%, and the probability of decreasing yield was 63% and 31% in the 2050s, at Jokioinen and Lleida, respectively, relative to 1981–2010. The contribution of crop model structure to the total variance of ensemble output was larger than that from

downscaled climate projections and model parameters. The relative contribution of crop model parameters and downscaled climate projections to the total variance of ensemble output varied greatly among the seven crop models and between the two sites. The contribution of downscaled climate projections was on average larger than that of crop model parameters. This information on the uncertainty from different sources can be quite useful for model users to decide where to put the most effort when preparing or choosing models or parameters for impact analyses. The triple-ensemble probabilistic approach that accounts for the uncertainties from multiple important sources provides more comprehensive information for quantifying uncertainties in climate change impact assessments.

***Title*: Elucidating Thermal Death of Cereal Grain Crops to Ensure Life**

Presenter: Gerard W Wall

Author: Wall, Gerard W[1], Laura M. Olivieri[1], Matthew M. Conley[1], Bernhard Schauberger[2] and Frank Wechsung[2]

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Abstract: Global climate uncertainty will alter thermal regimes of Earth's cereal grain production regions. Because semi-arid desert regions experience the widest range in ambient temperature (-2 to 42°C), intra- and inter-annual variations in temperature provides a cost effective means to assess thermal response of cereal grain simultaneously. To assess Genotype by Environment by Management (GxExM) interactions, we staggered planting dates, beginning in the normal cropping season of December, to be in shorter intervals during the March-June time frame. We used day-neutral cultivars lacking any verbalization requirement to negate any photoperiod effects and ensure floral induction regardless of planting date. Our objectives were: (1) determine cereal grain responses to a wide range of air temperature; (2) quantify crop growth; (3) evaluate and refine thermal response on cereal growth and development; (4) validate cereal growth models with regard to thermal dependent processes. Our materials of study included: Wheat (Tritium aestivum L.); Durum Wheat (T. durum L.); Barley (Hordeum vulgare L.); and, Triticale (xTriticumSecale) WheatxRye. These four cereal grains were planted, in four replicates, over five and eight dates (March to June) during 2016 and 2017, respectively, to assess the differently treated crop responses across a wide range in air temperature. Because rye is known to be the most heat tolerant, Triticale had greater biomass and yield. Heat tolerance was greater in Wheat and Durum compared with Barley. Results will be discussed in the context of their impact on global climate uncertainty, adaptation and mitigation strategies, and global food security.

***Title*: Improved temperature response functions in crop models reduced the uncertainty of wheat yield projections**

Presenter: Pierre Martre

Author: Dr Enli Wang[1]*, Pierre Martre[2]*, Zhigan Zhao[3,1], Frank Ewert[4,5], Andrea Maiorano[2], Reimund P. Rötter[6,7], Bruce A. Kimball[8], Michael J. Ottman[9], Gerard W. Wall[8], Jeffrey W. White[8], Matthew P. Reynolds[10], Philip D. Alderman[10], Pramod K. Aggarwal[11],

Jakarat Anothai[12], Bruno Basso[13], Christian Biernath[14], Davide Cammarano[15], Andrew J. Challinor[16,17], Giacomo De Sanctis[18], Jordi Doltra[19], Elias Fereres[20,21], Margarita Garcia-Vila[20,21], Sebastian Gayler[22], Gerrit Hoogenboom[12], Leslie A. Hunt[23], Roberto C. Izaurralde[24,25,] Mohamed Jabloun[26], Curtis D. Jones[24], Kurt C. Kersebaum[5], Ann-Kristin Koehler[16], Leilei Liu[27], Christoph Müller[28,] Soora Naresh Kumar[29], Claas Nende[l5], Garry O'Leary[30], Jørgen E. Olesen[26], Taru Palosuo[31,] Eckart Priesack[14,] Ehsan Eyshi Rezaei[4], Dominique Ripoche[32], Alex C. Ruane[33], Mikhail A. Semenov[34,] Iurii Shcherbak[13], Claudio Stöckle[35], Pierre Stratonovitch[34], Thilo Streck[22], Iwan Supit[36], Fulu Tao[31,37], Peter Thorburn[38], Katharina Waha[28], Daniel Wallach[39], Zhi

Abstract: While the multi-model ensemble modeling approach is useful to quantify prediction uncertainty in crop simulations, the approach itself does not necessarily lead to improvement in process understanding. We extend the model inter-comparison to investigate how the uncertainties in simulation results arise from process-level algorithms and parameterization in the models. We systematically compared 29 physiologically based wheat models in terms of how the key temperature-responsive physiological processes are simulated. We demonstrated that the variations in the mathematical functions currently used to simulate temperature responses of physiological processes in the 29 models account for more than half of uncertainty in simulated grain yields for mean growing season temperatures from 14_°C to 33_°C. We further developed improved general temperature response functions for key developmental and growth processes of wheat. Implementation of these temperature functions in four wheat models reduced the error in grain yield simulations across seven global sites with different temperature regimes covered by the IHSGE data.

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Session 3A: Nutrition and Food Security Metrics and Scenarios

***Title*:** **Sustainable diets in a global context**

Presenter: Pauline Scheelbeek

Author: Rosemary Green, James Milner, Francesca Harris, Edward Joy, Pauline Scheelbeek, Benjamin Kayatz, Jon Hillier, Sutapa Aggerwal, Andy Haines, Pete Smith, Alan Dangour

Abstract: The global food system is under pressure: ~800 million people are undernourished, over 2 billion people suffer one or more micronutrient deficiencies, and nutrition-related non-communicable diseases (NCD) have become the leading cause of death globally. The production of food also has major impacts on the environment. On-going and rapid changes to dietary patterns resulting from economic development and urbanisation are predicted simultaneously to increase NCD mortality and food-related environmental impacts.

Sustainable diets are defined as healthy, with low environmental impacts and positive contributions to social and economic development. Actions aimed at achieving sustainable diets are strongly context specific. For example in India, where groundwater for agricultural production is increasingly scarce, the blue water footprint (a measure of ground and surface water) of current diets is ~700L/capita/day (compared to only ~200L/capita/day in Europe). We modelled sustainable and healthy diets in India that meet projected population increase, and decrease blue water footprints by up to 30% in

2050. In contrast, in the United Kingdom, the majority of food is imported, and hence sustainable diets must pay more attention to the vulnerability to global food security issues including climate and trade barriers. To-date all sustainable dietary changes, that prioritise reducing environmental impacts as well as improving the nutritional composition of diets, are modelled and remain untested in real-world contexts. Through a range of methods such as optimisation modelling and health impact assessment, this research explores current challenges to the definition and implementation of sustainable diets, with a particular focus on trade-offs and co-benefits for agriculture, nutrition, health and the environment.

***Title*: Modeling the Effect of Environmental Conditions on Health-promoting Compounds of Melons**

Presenter: Bhimanagouda Patil

Author: Bhimanagouda S. Patil[1], Sangmesh V. Angadi[3] and Senthold Asseng[3]

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Abstract: Globalization and advances in science have helped to reduce food insecurity, but the triple burden of malnutrition (hunger, nutrient deficiency, and obesity) affects millions of people in many countries around the globe. Addressing malnutrition will require systems approaches that incorporate targeted steps in research and education that encompass the full scope of food production, from table to farm, providing feedback from consumers to producers, plant breeders, and crop modelers. Moreover, these approaches must shift from commodity crops grown to incorporate underutilized crops, like fruit and vegetables, that provide high nutrient levels and are well adapted for growth in specific regions, particularly the tropics and sub-tropics.

Changing climate can affect human beneficial compounds of many fruits and vegetables and one of the major challenges in addressing malnutrition is the limited availability of information related to climate change, water scarcity, and loss of biodiversity on quality and nutritional properties of fruits and vegetables. Our results on pepper, bitter melon and grapefruit suggest that the environment has a significant effect on selected health-promoting components.

To address this lack of data, a multistate project spanning seven states with diverse agro-climates will focus on understanding the role of different environmental parameters on multiple nutritional and health-beneficial compounds in melon varieties; this project has been initiated with USDA-SCRI funding. The latitudinal and longitudinal range of the locations provides the environmental diversity needed to identify key factors that influence different health-promoting components in melons. Multivariate regression analysis will be used to quantify relationships between growing season weather parameters and biomolecule accumulation. These regression equations will be a useful tool to assess the effect of climate change on vegetable health benefits.

***Title*: The health burden of red and processed meat consumption**

Presenter: Marco Springmann

Author: Springmann, Marco[1]

[1] University of Oxford

Abstract: The consumption of red and processed meat exceeds recommended levels in most high and middle-income countries and has been associated with a range of negative health impacts. Here we estimate the health burden associated with red and processed meat consumption.

The environmental impacts were quantified using country-specific emissions intensities, and monetised using estimates of the social cost of carbon. The health burden was assessed by using a comparative risk assessment framework with four disease endpoints associated with red and processed meat consumption: coronary heart disease, stroke, colorectal cancer, and type 2 diabetes mellitus. The health impacts were monetised by using data on health expenditure and cost of illness.

According to our model projections, the consumption of red and processed meat was associated with 850,000 and 1,500,000 deaths globally in the year 2020, which together represented 4.4% of all projected deaths in the analysis in that year. About two thirds of attributable deaths occurred in middle-income countries, one third in high-income countries, and a small portion (4%) in low-income countries. The associated costs related to health care amounted to USD 290 billion, which represented 0.3% of expected world GDP in that year.

Our estimates highlight the potential benefits of dietary changes towards low-meat diets.

***Title*: The effect of environmental change on yields and nutritional quality of fruits, vegetables & legumes, and their relevance for food & nutrition security**

Presenter: Pauline Scheelbeek

Author: Pauline Scheelbeek[1], Frances Bird[1], Cami Allen[1,] Hanna Tuomisto[2], Rosemary Green[1], Francesca Harris[1], Edward Joy[1], Zaid Chalabi[1], Elizabeth Allen[1], Andy Haines[1], Alan Dangour[1]

[1] London School of Hygiene & Tropical Medicine

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Abstract: Environmental changes put pressure on agricultural production, food security and health. Mapping the magnitude of environmental impact on food production and nutritional quality under a business-as-usual scenario can help identify potential concerns for global food security. Yields of starchy staples are predicted to decline substantially under future environmental scenarios. Impacts on fruits, vegetables and legumes (FVL) - important constituents of healthy diets – have not been studied.

We systematically reviewed published experiments in the literature for the effect of five environmental exposures on FVL yields and nutritional quality. We estimated mean effects of standardised environmental changes and conducted meta-analyses. In a business-as-usual scenario, we contextualised the identified impacts of yield reductions on global FVL trade and assess the potential effects on FVL consumption in the UK.

We identified 229 relevant papers from 51 countries. We found significant positive effects on yields for 250ppm increase in CO2 concentration. Significant negative effects were found for 50% reduction in water availability and exposure to 4°C increase in

temperature (for papers with baseline temperatures >20°C). Yields effects of increased salinity and O3 concentration showed mixed results. The impacts on nutritional quality varied by crop type and environmental exposure. Reduced global FVL yields affected UK market prices, which – especially in low-income households – was forecasted to result in a reduced household FVL consumption.
Low intake of FVL is the second largest dietary risk factor for global burden of disease. Given its global trade character, changes in FVL yields may have serious consequences for global public health in the mid- to long-term. Integrated transformative changes in the environment, food system and trade sectors are needed to divert current trajectories and prevent substantial negative impact on global food security.

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Session 3B: Crop Model Intercomparison in Diverse Systems

***Title*: Testing multiple rice crop models against free-air CO2 enrichment and chamber experiments to improve yield responses to elevated CO2 and temperature**

Presenter: Kenneth J. Boote

Author: Kenneth J. Boote[1], Toshihiro Hasegawa[2]*, Jeffery T. Baker[3], Tao Li[4], Xinyou Yin[5], Yan Zhu[6]*, Leon H. Allen, Jr.[7], Samuel Buis[8], Roberto Confalonieri[9]*, Job Fugice[10], Tamon Fumoto[2], Donald Gaydon[11], Soora Naresh Kumar[12], Tanguy Lafarge[13], Manuel Marcaida III[15], Yuji Masutomi[16], Ermes Movedi[9], Hiroshi Nakagawa[2], Livia Paleari[9], Diego N.L. Pequeno[17], Françoise Ruget[8], Upendra Singh[10], Liang Tang[7], Fulu Tao[18], Hitomi Wakatsuki[2], Lloyd Ted Wilson[19]*, Yubin Yang[19], Hiroe Yoshida[2], Zhao Zhang[20]

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[7] United States Department of Agriculture

Abstract: For irrigated rice production, which accounts for about 75 % of the world production, CO2 and temperature are the primary environmental factors that determine the effects of climate change on productivity. Our initial intercomparison of rice models showed that model predictions under elevated CO2 and temperature vary substantially among crop models. To determine the source of the uncertainty, a total of 16 rice models were tested against observations made in the free-air CO2 enrichment (FACE) and in the Soil Plant Atmosphere Research (SPAR) chambers. The model ensemble reproduced the observed yield and biomass in FACE and chambers well but predicted yields in response to elevated [CO2] varied significantly among the rice models. The variation was not associated with model structure or magnitude of photosynthetic response to elevated [CO2] but was significantly associated with the predictions of leaf area index, which suggests that modelled secondary effects of elevated [CO2] on morphological

development are the sources of model uncertainty. However, the model ensemble failed to reproduce response to elevated temperatures observed in the SPAR chamber experiments: Most models overestimated yields at high temperatures, largely because of failure in simulating reproductive growth, especially grain number or carbon partitioning to the grains, in response to elevated temperatures. The results suggest a strong need for improvement in leaf area development in elevated CO2 and grain number or carbon partitioning in high temperature range.

***Title*: A Summary of Research Activities from the AgMIP Potato Crop Modeling Intercomparison Pilot**

Presenter: David Fleisher

Author: Fleisher, David [1], Condori, Bruno[1], Quiroz, Roberto, Alva, Ashock, Asseng, Senthold, Barreda, Carolina, Berguijs, Herman, Bindi, Marco, Boote, Ken, Craigon, Jim, Fangmeier, Andreas, Ferrise, Roberto, Franke, Linus, Gayler, Sebastian, Govindakrishnan, P.M., Harahagazwe, Dieudonne, Hoogenboom, Gerrit, Kremer, Pascal, Kroes, Joop, Kumar, Soora Naresh, Merante, Paolo, Nendel, Claas, Olesen, Jorgen, Parker, Phillip, Pleijel, Hakan, Raes, Dirk, Raymundo, Rubi, Reidsma, Pytrik, Ruane, Alex, Silva, Joao, Stella, Tommaso, Stockle, Claudio, Supit, Iwan, van evert, Fritz, Vandermeiren, Karine, Vanuytrecht, Eline, Vorne, Virpi, Wolf, Joost, Woli, Prem.
[1] USDA-ARS

Abstract: Activity-1 of the potato crop model intercomparison pilot was recently completed and focused on quantifying multi-model uncertainty to climate responses when using common data sets from low- and high- input management sites. Median model ensemble response outperformed any single model in terms of replicating observed yield across all sites. Uncertainty among models averaged 15% higher for low- versus high- input sites, with larger differences observed for evapotranspiration (ET), nitrogen uptake, and water use efficiency as compared to dry matter. A minimum of five partial, or three full, calibrated models was required for an ensemble approach to keep variability below that of common field variation. Model variation was not influenced by carbon dioxide (C), but increased as much as 41 and 23% for yield and ET respectively as temperature (T) or rainfall (W) moved away from historical levels. Increases in T accounted for the highest amount of uncertainty, suggesting that methods and parameters for T sensitivity represent a considerable unknown among models. Activity-2 research is on-going and tests the capability of multiple models to mimic effects of elevated C concentration on potato yields measured at eight different locations in Europe. A subset from observed OTC and FACE data was used to initially calibrate the models. This research will also evaluate the stability of the models' calibration with respect to changes in geographic location, as the same variety was used in all locations. This presentation will summarize the Activity-1 results and discuss the current status of Activity-2 investigations.

***Title*: How reliable are current crop models to simulate canola growth and seed yield?**

Presenter: Ward Smith

Author: Enli Wang[1]*, Di He[2,1,3], Jing Wang[3]*, Julianne M. Lilley[1], Brendan Christy[4], Munir P. Hoffmann[5], Garry O'Leary[4], Jerry Hatfield[6], Luigi Ledda[7], Paola A. Deligios[7], Brian

Grant[8], Qi Jing[8], Claas Nendel[9], Henning Kage[10], Budong Qian[8], Ehsan Eyshi Rezaei[11,12], Ward Smith[8], Wiebke Weymann[10], Frank Ewert[11,13]
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[7] Department of Agriculture, University
Abstract: The first comprehensive study on inter-comparison of eight crop models for simulating growth and grain yield of canola crop was completed, based on experimental data from six sites across five countries. Our results contrast with those from previous model inter-comparison studies for wheat, maize, rice and potato crops. A partial model calibration only on phenology led to poor simulation of aboveground biomass and seed yield of canola. A full calibration with additional data of LAI, biomass and yield from one treatment at each site reduced simulation error of seed, but the uncertainty in simulation results remained large, due to the different approaches used to simulate key physiological processes in response to environmental factors. The multi-model ensemble approach helps quantify uncertainty, but cannot reduce simulation error, thus no guarantee that it provides the best projection. Improved process modelling with targeted data is needed to increase simulation reliability.

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Session 3C: Soil nutrient and Water Management Strategies

***Title*: Coupling crop and soil organic matter models to assess crop resilience to climate change and variability by the adoption of conservationist management systems**
Presenter: Marcelo Galdos
Author: Galdos, Marcelo [1,2], Falloon, Pete [2] , Challinor, Andy [2]
[1] University of Leeds
[2] UK Met Office
Abstract: Besides supporting food, feed, fuel and fibre production, soils provide ecosystems services such as storing carbon, filtering water and maintaining biodiversity. Fertile soil is being lost at the rate faster than it can recovered, primarily from inadequate agricultural management practices and by climate change. Conservation agriculture is a key aspect of the climate-smart approach, combining reduced soil disturbance, as in no-till and minimum tillage systems; maintenance of permanent soil cover with crops or mulch from crop residues; and increased crop diversity through rotations and intercropping. Potential benefits from such systems include increased organic matter content, reduced soil losses from erosion, and increased resilience to climate extremes. Soil organic matter dynamics

are not usually represented in detail in most crop models, which predominantly focus on above-ground biomass production and grain yields. We propose combining widely used crop models with soil organic models to assess the potential increase in resilience to climate change and variability by the adoption of conservationist management systems. The soil organic matter models Daycent and ECOSSE will be coupled with the crop models JULES-Crop and GLAM to simulate water, carbon and nitrogen stocks and fluxes in the plant/soil/atmosphere at the site scale. Gridded soil and climate datasets will be used to upscale model simulations to landscape and regional scales. Regionally-specific business as usual and mitigation scenarios will be identified, and climate models will be used to run future scenarios with focus on crop yields, soil carbon and soil nitrogen dynamics.

***Title*: The Global Microlysimeter Network to inform crop models on nitrogen mineralisation of soils**

Presenter: Claas Nendel

Author: Nendel, Claas[1], Melzer, Dennis[1], Thorburn, Peter[2]

[1] Leibniz-Centre for Agricultural Landscape Research, Eberswalder Straße 84, 15374 Müncheberg, Germany

[2] CSIRO Agriculture, Integrated Agricultural Systems, St Lucia, Queensland, Australia

Abstract: Crop models have developed into a central tool for predictions of global food security under changing framework conditions. Being globally applied in a range of studies, parameterization and validation efforts concentrate primarily on the plant part of the model, but not on the soil part. The majority of the models assumes natural nitrogen supply to the crop as a result of processes that dominate in soils of temperate climate. The deviating features of soils that developed under tropical and subtropical climate are rarely represented in such models. The Global Microlysimeter Network set off to produce a data set of nitrogen mineralisation from agricultural soil under field conditions across a wide range of climate and soil combinations. Currently, 15 Partners have installed (or are installing) microlysimeters at their home institutions, covering seven major climate zones. Microlysimeters provide an easy-to-simulate soil system section that give clue to the amount of nitrogen being released from stabilised organic matter in agriculturally used soils over time. Provided sufficient water drainage, the shallow dimension of the microlysimeter assures a timely leaching of the mobile nitrogen compounds soon after their formation. This is a pattern that agro-ecosystem models are able to mimic and inverse modelling will find mineralisation parameters that fit the cumulative outflow of mineral N from the microlysimeter soil. This presentation explains the background of the methodology and advertises the network, as a few more partners are needed to complete the experimental design. Results to feed into a model improvement exercise are expected for 2020.

***Title*: Prediction of Evapotranspiration and Yields of Maize: An Inter-comparison among 29 Maize Models**

Presenter: Kimball, Bruce A.

Author: Nendel, Claas[1], Melzer, Dennis[1], Thorburn, Peter[2] Kimball[1], Bruce A., Kenneth J. Boote[2], Jerry L. Hatfield[3], Laj R. Ahuja[4], Claudio Stockle[5], Sotirios Archontoulis[6], Christian Baron[7], Bruno Basso[8], Patrick Bertuzzi[9], Julie Constantin10, Delphine Deryng11, Benjamin Dumont12, Jean-Louis Durand13, Frank Ewert[14,15], Thomas Gaiser[15], Sebastian Gayler[16], Munir Hoffman[17], Qianjing Jiang[18], Soo-Hyung Kim[19], Jon Lizaso[20], Sophie Moulin[21], Claas Nendel[14], Philip Parker[14], Taru Palosuo[22], Eckart Priesack[23], Zhiming Qi[18], Amit Srivastava[15], Tommaso Stella[14], Fulu Tao[22,24], Kelly Thorp[1], Dennis Timlin[25], Tracy E. Twine[26,] Heidi Webber[15], Magali Willaume[10], Karina Williams[27]

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Abstract: An important aspect that determines the ability of crop growth models to predict growth and yield is their ability to predict the rate of water use or evapotranspiration (ET) of the crop, especially for rain-fed crops. In a prior inter-comparison among maize growth models, ET predictions varied widely, but no observations of actual ET were available for comparison. Therefore, another study was initiated under the umbrella of AgMIP. This time observations of ET using the eddy covariance technique from an 8-year-long maize experiment conducted at Ames, IA were used as the standard. Simulation results from 29 models have been completed. In the first "blind" phase for which only weather, soils, and management information were furnished to the modelers, estimates of seasonal ET varied from about 200 to about 700 mm. Detailed statistical analyses of the daily ET data from showed that, as expected, the median of all the models was more accurate across several statistical criteria than any particular model. However, some individual models were better than the median for particular cases. Predictions improved in later phases when the modelers were provided additional leaf area, growth, and the actual ET observations that allowed them to "calibrate" some of the parameters in their models to account for varietal characteristics, etc. However, the range of ET estimates was only reduced by about half, so it was still large. Nevertheless, some models generally gave respectable estimates, and the more successful approaches were identified.

***Title*: Backward simulation of nitrogen fertilizer effect on maize growth and yield**

Presenter: Yang, Haishun

Author: Yang, Haishun[1]; Krienke, Brian[1].

[1] University of Nebraska - Lincoln

Abstract: We developed a ‚Äòbackward‚Äô method to simulate N fertilizer effect of maize growth and yield in the current Hybrid-Maize model. It requires readily available information, including the amount of fertilizer N to be applied, crop management level, prices of fertilizer and maize, and a known maize yield at a known fertilizer rate (or without fertilizer) from the past. The ‚Äòbackward‚Äô simulation method first estimates the possible yield for the given N rate, then goes back to simulate corresponding crop daily growth. The simulation process comprises four steps. Firstly, it simulates the yield

potential without N limitation. Secondly, it calculates crop N uptake from soil sources by means of the user-specified known yield at the known N rate via a pre-established yield to N uptake response function. Thirdly, it calculates crop total N uptake for the season and corresponding yield, as well as the economically optimal N rate (EONR). Finally, it uses an iteration procedure to apply an increasing N stress rate to simulate daily photosynthesis, respirations, dry matter partitioning, leaf area expansion, biomass accumulation, and crop water use and soil water balance until the final yield matches the yield for the given N rate obtained at the third step. While this approach has the advantages of using only readily available information estimate N contribution from soil, it does rely on two assumptions: correct setting of fertilizer recovery efficiency, and a constant N stress rate throughout the crop growth cycle. For the former, local calibrations can greatly improve simulation results.

***Title*:** **Land degradation and food security: impacts and adaptation options**

Presenter: Alvaro Calzadilla

Author: *Calzadilla* Alvaro[1] and Carr, Tony[1]

[1] University College London

Abstract: Land degradation is estimated to affect more than a quarter of the global land area. Together with climate change, land degradation is expected to increase the risk of food security in many regions of the world. Land degradation reduces the quality of the soil, which declines crop yields, production volumes and farming incomes. Land degradation and climate change are interlinked processes. Recent literature suggests that land degradation has the potential to influence the magnitude and direction of climate impacts and effectiveness of adaptation options. We use the global computable general equilibrium model ENGAGE to assess the potential economic impacts of land degradation across countries and across sectors. The ENGAGE model has been specially designed to assess agricultural and land use policies. It includes agro-ecological zones, first generation biofuels and irrigation. The relationship between soil nutrients losses and crop yields is modelled at the global scale by the biophysical crop model EPIC. The results show that if the natural nutrients in the soil are not replaced with fertilisers or natural sources crop yields decline. This depletion of nutrients leads to nutrient mining compromising the long-term sustainability of agricultural systems and declining the economic benefits. Economic losses due to land degradation are considerable in developing countries, thus integrating to the policy mix adaptation strategies tackling land degradation is crucial for regional and global food security.

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Session 3D: Climate Change Impacts on Biophysical Systems #2

***Title*:** **InfoCrop DSS aided adaptation to climatic risks in agriculture: Case study from farmersâ€™ fields in India**

*Presenter**:** S. Naresh Kumar*

Author: S. Naresh Kumar, SK Bandyopadhyay, RN Padaria, AK Singh, Md. Rashid, Md. Wasim and D.N Swaroopa Rani

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Abstract: In a World Bank-GEF project, InfoCrop models were used to quantify the past, current and future climatic risk related loss to productivity of wheat, mustard, maize and soybean in climatically vulnerable villages ie., 11 in Mewat district of Haryana and 13 in Dhar district of Madhya Pradesh. To capture the variability in the potential impacts of climatic risks and adaptation gains in different farms in 24 villages, different management combinations along with varietal variations were input into the model. Simulation analysis indicated that continuation of current management and verities will lead to significant yield loss. For example, wheat experiences early and terminal heat stress during winter season (rabi; Nov.-April) leading to yield loss, while soybean yield performance is strongly correlated to the optimal rainfall and distribution during monsoon season (kharif; June-Oct.). Changing variety and sowing time were found easy to adapt and low-cost technologies to minimize climatic risks. Simulation analysis based short-listed varieties were sown in 24 villages covering about 3500 farms. Yields from different varieties of four crops were compared by taking the samples at 1m2 area. Such introduction of improved varieties enhanced the yield levels in the range of 8-40% under all conditions of management. Percentage of farms falling in the high-yield level group increased. This clearly demonstrated that the outputs from decision support systems such as InfoCrop can be successfully used for implementing adaptation to climatic risks.

***Title*: Climate change impact on the yields of cereals in smallholder settings in West Africa: The case of Nioro, Senegal and Navrongo, GhanaClimate change impact on the yields of cereals in smallholder settings in West Africa: The case of Nioro, Senegal and Navrongo, Ghana**

Presenter: Dilys S. MacCarthy

Author: Dilys S. MacCarthy [1], Samuel G. K. Adiku [2], Bright S. Freduah [1], Myriam Adam [3], Mouhamed Ly [4], Ibrahima Haithie [5], Sibiry P. Traore [6]

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Abstract: The production of cereals in West Africa is constraint by several yield limiting factors such as poor soil fertility and erratic rainfall distributions and is largely dominated by smallholder farmers. Projected changes in climate thus poses a threat since crop production is mainly rainfed. In this study, two crop models; Decision Support System for Agro-technological Transfer (DSSAT) and Agricultural Production Systems sIMulator (APSIM) were calibrated, evaluated and used to quantify climate change impact on the yield of maize, sorghum and millet under future production systems in Nioro, Senegal and Navrongo, Ghana. Data on management practices (sowing dates, time

and amount of fertilizer) obtained from household surveys, soil data, weather data (historical; 1980-2009 and 5 Global Circulation Models (GCMs); Mid Century time slice 2040 – 2069 for two representative concentration Pathway (RCP); 4.5 and 8.5) were used for the impact assessment. Temperatures were projected to increase in both study areas with higher temperatures for Nioro. Change in total rainfall amounts varied in Nioro with rains in Navrongo to remain same or increase slightly. Ensembled maize yield changes under RAP 4 were between -22 to -1% in Nioro, and -19 to 0 in Navrongo for DSSAT and APSIM respectively. The impact of climate change on sorghum and millet were lower than those of maize. Yield reductions under RAP 5 were generally higher than under RAP 4. The extent of yield loss varied among households due to differences in management practices and soils. There is need to explore potential adaptations to reduce yield loses.

***Title*: Evolving climate resilient crop systems through integrated climate and crop modeling: A case study from Tamil Nadu**

Presenter: V. Geethalakshmi

Author: V. Geethalakshmi[1], A.P. Ramaraj[1], K. Bhuvaneswari[1], N. Manikandan[1], R. Gowtham[1], A. Lakshmanan[1], Sonali McDermid[1], K. Senthilraja[1], K. Vinothkumar[1].

[1] Tamil Nadu Agricultural University

Abstract: Climate change in recent times put forth a great challenge for research community to quantify its local impact on the of agricultural systems. Assessment of the impacts on agricultural production should take comprehensively into account available adaptation strategies, and account for the uncertainties from many physical, biological, and social-economic processes. For simulation of these impacts, usually a climate model coupled with a mechanism-based crop growth model is employed. The present work on climate change concentrates on the impacts at local scale considering cascaded uncertainties from climate to crop models associated with it. The research work presented here is a part of Agricultural model Inter-comparison and Improvement Project (AgMIP). The maximum (RCP 4.5: 0.2 to 2.9°C, RCP 8.5: 0.2 to 4.6°C) and minimum temperature (RCP 4.5: 0.3 to 3.0°C, RCP 8.5: 0.4 to 5.2°C) over the study location trichy is projected to increase while rainfall is projected to vary widely (RCP 4.5: -13 to 58 %, RCP 8.5: -9 to 65 %) based on the models. The uncertainty in projections of climate models and its cascading effect of crop models were simulated to devise better crop adaptations. Rice and Maize crops were taken for the study to represent the two major photosynthetic pathways. Altered date of sowing and supplemental fertilizer application proved to sustain the yield levels of both the crops.

***Title*: Field warming experiments constrain global crop yield reductions under Paris' global warming targets**

Presenter: Xuhui Wang

Author: Wang, Xuhui[1,2], Zhao, Chuang[1], Piao, Shilong[1,3,4], Ciais, Philippe[1,2], Müller, Christoph[5], Janssens, Ivan[6], Peñuelas, Josep[7,8], Senthold, Asseng[9], Li, Tao[10], Elliot, Joshua[11], He, Yue[1], Huang, Mengtian[1], Huang, Yao[12], Li, Laurent[13], Li, Xiangyi[1], Lian, Xu[1]

Abstract: Responses of global crop yields to warmer temperatures are fundamental to food security under climate change but remain uncertain (1, 2). We combined a global data-set of field warming experiments (48 sites) for wheat, maize, rice and soybean with gridded global crop models (3) to produce field-data-constrained estimates of responses of crop yield to temperature changes (ST). The new estimates show with >95% probability that warmer temperatures will reduce yields for maize (-7.1±2.8%K-1), rice (-5.6±2.0%K-1) and soybean (-10.6±5.8%K-1). For wheat, ST was 89% likely to be negative (-2.9±2.3% K-1). The field-observation constraints reduced uncertainties in modeled ST by 12-54% for the four crops. Key implication for impact assessments after Paris Agreement is that limiting global warming within 2 K will still reduce major crop yields by 3% to 13%. Even if warming was limited to 1.5 K, none of major producing countries would likely benefit from warmer temperatures.

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Session 3E: Global Agricultural Modeling for Development and Climate Analysis #2

***Title*: A Systems Approach to Characterize the Tradeoff between Food Security and Environmental Impacts**

Presenter: Anjuli Jain Figueroa

Author: Anjuli Jain-Figueroa [1], McLaughlin, Dennis [1]

[1] M.I.T

Abstract: Many estimates suggest that the world needs a 50-70% increase in food production to meet the demands of the wealthier 2050 global population. Cropland expansion and yield improvements may not be sufficient and surmise additional environmental damage. This work presents a framework that combines optimization methods, global data sources, and hydrologic modeling, to identify the tradeoffs and links between food production, crop revenue and environmental impacts. We focus our case study in India's Krishna river basin, a semi-arid region with a high proportion of subsistence farmers, a diverse mix of crops, and increasing water stress (river basin closure). The work focuses on reallocating limited land and water resources to optimize cropping patterns in order to use the resources more efficiently. It is intended as a decision support system to inform resource allocation and improve the sustainability of farming systems.

***Title*: Crop yield change and feedbacks on land-use and management over the 21st century**

Presenter: Sam Rabin

Author: Sam Rabin[1], Alexander, Peter[2], Henry, Roslyn[2], Anthoni, Peter[1], Pugh, Thomas[3], Rounsevell, Mark[1], Arneth, Almut[1]

Abstract: The global agricultural system will need to adapt to feed the world in a future of increasing atmospheric carbon dioxide concentrations, changing climate, increasing human populations, and changing socioeconomic conditions. Global modeling can help to explore these adaptations, but because of complex interconnections among terrestrial ecosystems and society, these different parts of the Earth system must be examined as an interconnected whole.

To that end, we have coupled the global vegetation model LPJ-GUESS with the land-use model PLUMv2. LPJ-GUESS provides potential crop yields under different management levels in a variety of climatic futures, which PLUMv2 uses to generate land-use and -management trajectories. These are then fed back into LPJ-GUESS to simulate the future of the land system as a whole. This system allows us to test the relative contribution of different drivers to the trajectories by holding individual variables, such as carbon dioxide concentration, constant.

Here, we explore how global agricultural areas, inputs, and yields will change in the future given different scenarios of climate change and socioeconomic development. This involves assessing how changes in potential yield due to environmental change filter through the larger socio-agricultural system to influence management, crop choice, and land-use decisions, which then ultimately affect the global trajectories in actual yield and production of agricultural commodities. We thus show how the whole global agricultural system may adapt to changes in climate and socio-economic drivers, leading to very different projections of future yields than from biophysical crop models alone.

***Title*: Agricultural response functions for integrated assessment models based on the C3MP data set.**

Presenter: Abigail Snyder

Author: Abigail Snyder [1] , Ruane, Alex[2], Phillips, Meridel[3], Calvin, Kate[1], Clarke, Leon

[1] Joint Global Change Research Institute, Pacific Northwest National Lab

[2] NASA-GISS

[3] Columbia University

Abstract: Research is increasingly showing that agricultural yields are susceptible to changes in temperature, precipitation, growing season length, CO2 concentrations, and other Earth system factors. While both the nature of the future climate and its impact on agricultural yields are highly uncertain, it is clear that there is potential for important effects on major agricultural producers such as the United States.

Global gridded crop models estimate the influence of these changes on future crop yields, but are often too computationally intensive to dynamically couple into economic models, like Integrated Assessment Models (IAMs). Yet, generalizing a faster site-specific crop model's results will introduce inaccuracies, and the question of which model to use is unclear given the wide variation in yield response across crop models. To examine the feedback loop among IAMs, Earth System Models, and crop models, rapidly generated yield responses with some quantification of crop model uncertainty are desirable.

The response functions presented in this work are based on the C3MP sensitivity test data set and are focused on providing IAMs with "guardrails" to examine feedback loops and improve agricultural representations. Specifically, we distinguish between precise forecasts and getting rough magnitude and direction for distinct crop-region-climate scenarios. We seek biologically reasonable response functions that are more dynamic than past options for incorporating crop responses. The response surfaces represent the large uncertainty in yield response across crop models to a given change in earth system state. Because of our perturbation-based approach, we can address the overlapping space between climate and response uncertainty.

***Title*: Agricultural adaptation: constraints and compensation opportunities to changes in temperature, precipitation and CO2 - a global multi-model analysis**

Presenter: Florian Zabel

Author: Zabel, Florian, Dury, Marie, Elliott, Joshua, Folberth, Christian, Francois, Louis, Liu, Wenfeng, Minoli, Sara, Müller, Christoph, Ruane, Alex C., Sakurai, Gen

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Abstract: It is becoming increasingly important for agriculture to adapt to the no longer avoidable impacts of climate change. In order to specifically develop and support adaptation strategies and feasible measures, it is required to identify potentials and constraints for different adaptation measures. Temperature, Precipitation, CO2 and soil properties are the most important determinants for agriculture upon which agricultural management influence yields. Breeding as well as genetic improvements in plant physiology provide a range of crop cultivars that are adapted to specific abiotic conditions. Cultivar selection is an important management option that can be seen as a major component of adaptation. Global gridded crop models take the complex interplay within the soil-plant-atmosphere continuum at the local scale into account and are able to consider management options. Thus, they are able to consistently simulate adaptation measures under changed climate conditions at the global scale and identify regional differences. Adaptation is consistently implemented to the participating models so that the growing period in a warmer climate remains the same length than the original growing period derived from statistics.

In a global muli-model sensitivity analysis, we investigate the combined effects of environmental changes on yields for adapted cultivars. We show first results on how adaptation impacts on global yields for the major crops maize, wheat, rice and soybean. The models agree that more water availability as well as increased atmospheric CO2 concentrations in global average increase the effect of cultivating an adapted variety. The study reveals by how far abiotic changes can be compensated by adaptation. Variabilities across the models as well as uncertainties are quantified. We found an unequal global distribution of potentially benefiting and constrained countries, mainly due to occurring water- and heat stress in later phenological stages.

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WWC1A: Global Agricultural Modeling for Development and Climate Analysis #1

***Title*: Climate impacts on Canadian productions of major crops for global warming levels of 1.5, 2.0 and 2.5°C**

Presenter: Budong Qian

Author: Qian, Budong [1], Zhang, Xuebin [2], Smith, Ward [1], Grant, Brain [1], Jing, Qi [1], Cannon, Alex [2], Neilsen, Denise [1], McConkey, Brian [1], Li, Guilong [2], Bonsal, Barrie [2], Wan, Hui [2], Xue, Li [3], and Zhao, Jun [3]

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[3] Strategic Policy Branch, Agriculture and Agri-Food Canada

Abstract: Background: Science-based assessments of climate change impacts under different levels of global warming are essential for stakeholders with regard to global climate targets. For a northern country such as Canada, a moderate increase in temperatures could improve crop production, however higher temperatures would eventually result in negative impacts on crop yields. A comprehensive evaluation of climate change impacts on Canada,Äôs crop production under different levels of global warming is currently lacking. The DSSAT, DNDC and DayCent models were employed to estimate changes in crop yields for three major crops including spring wheat, canola and maize for current agricultural regions in Canada. We considered three warming scenarios including global mean temperature changes of 1.5, 2.0 and 2.5ÀöC above the pre-industrial level. Climate scenarios from 20 Global Climate Models, included in the Coupled Model Intercomparison Project Phase 5 downscaled with a multivariate quantile mapping bias correction method, were used to drive the crop simulation models. Simulated changes in crop productions demonstrate a potentially positive impact on spring wheat and canola yields at all three temperature levels in association with the elevated atmospheric CO2 concentration, even with current cultivars. For the currently utilized short-season cultivars, an increase or little change in maize production depends on the crop model in the projection. Large uncertainty related to climate scenarios was observed for the projected changes in crop production.

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WWC1B: Regional Assessments of Biophysical and Economic Systems #1

***Title*: Overview of the suggestion for the establishment of the Grazing Reserve Bill and the Farmer – Herdsmen Rifts in Nigeria.**

Presenter: Michael Adedotun Foundation

Author: M. A. Oke. Author Affiliation Michael Adedotun Oke Federal Capital Territory Agricultural Development Program and Michael Adedotun Oke Foundation Plot 232 Kaida Road Old Kutunku Gwagwalada.

Abstract: The Law governing the establishment of grazing reserves in Nigeria started in 1965 later in 1978, the land Acts was extended to cover it. In 1988 National policy also earmarked 10 percent of the total National Territory for grazing areas that is 9.8 million hectares of land were earmarked in 1988 for grazing reserves. That figure was later

increased to 20 Million hectares. This paper supported the establishment of the Grazing reserve bill, which is the objectives to review different views, after considering the different write up in the daily newspaper of 2015 and 2016 and pictures. There are less than three million hectare gazette grazing areas which cover about three million. We have about 415 grazing areas and grazing reserves. Out of the 415, 141 were gazette. And those 141 reserves gazette cover only about three million hectares of land, it has been damaged by ecology, encroachment. The clashes came as result of the absence of developed grazing reserves and the protection of those reserves, suffered a lot of neglect because the pastoralist livelihood has been frequently undermined by unfriendly policies and laws. The polices of the past administration have given more attention to agronomy and not livestock sector that is what has caused this problems, three million hectares have been destroyed. The forestry units must work effectively to protect the reserves.

***Title*: The marketing of Carrots and the advantage of using Bottle water and used plastic materials in the Federal Capital Territory Abuja Nigeria.**

Presenter: Michael Adedotun Oke

Author: Michael Adedotun Oke

Michael Adedotun Oke Foundation

Abstract: In the Agricultural sectors the used of bottles, plastic, nylons cannot been overemphasize, due to the important of use in respect of the packaging, transportation and marketing strategies wise, which promote effective marketing and adding value to promote profitability and increase sales of an average sellers and encourage buyers and also reducing the weight that will make it easily transported and protect the shelf life of an average crop in the Agricultural sectors.

This paper therefore study a marketers that have being using bottle water in the strategies of prolonging the shelf life of an average carrots. Some of the marketers use the water inside too cool the carrots in which is going to preserve the self-life and some of the nylon are laying down in which they use to displayed some of the products in the markets which promote profitability and encourage more buyers to get close to the customers and various questions were ask from the buyers and sellers. Pictures were taken too support findings. This paper therefore stressed for effective means of marketing and technology development in areas of preservations and prolonging the life shelf of the carrots.

***Title*: Impacts and management strategies under climate change on maize yield in Brazil.**

Presenter: Paulo Sentelhas

Author: Bender, Fabiana D.[1], Sentelhas, P. C.[1]

[1] Department of Biosystems Engineering, ESALQ, University of São Paulo, 13418-900 Piracicaba, Brazil.

Abstract: Brazil appear as the third largest maize producer in the word, with production obtained in two seasons: 1st and 2nd growing season, both predominantly rainfed. With maize yield being influenced by the interaction of several factors, such as soil, climate and management, future climate projections of increase in temperature and possible reduction of soil water availability should affect the current levels of crop yield.

In this sense, DSSAT-CSM-Ceres Maize model, calibrated and validated under Brazilian conditions, was employed to determine the impact on maize grain yield under climate change scenarios from CMIP5, in an intermediate (RCP4.5) and high (RCP8.5) emission scenarios, for a short (2010-2039), medium (2040-2069) and long (2079-2099) term periods.
Future climate will promote yield losses in relation to the current climate (1980-2009) in both maize growing seasons, ranging from 41 to 61% for the 1st, and 58 to 65% for the 2nd season, due to the reduction in the crop cycle and increase of the relative water consumption. Different management strategies, such as sowing dates, alteration of cultivar cycle, irrigation and nitrogen fertilizer, were also simulated to minimize the impacts under climate change scenarios. These techniques, when combined, showed the possibility of yield loss mitigation under future climate change, mainly when irrigation was considered.

***Title*: The missing link - adding a spatial component to AgMIP's Regional Integrated Assessments (RIA) to upscale and map the impact of climate on crop production and economics**

Presenter: Davide Cammarano
Author: Durand, Wiltrud[1], Crespo, Olivier[2], Fourie, Andries[3], Cammarano, Davide[4], Ngwenya, Hlamalani[5], Mpusaing, Thembeka[6], Tesfhuney, Weldemichael A.[7], Walker, Sue[8]
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Abstract: For Regional Integrated Assessments (RIA) AgMIP has developed a range of climate, crop, and economic modeling tools, protocols and methodologies that integrate stakeholders' feedback for assessing the impacts of climate change on agricultural systems to enhance adaptation capacity. AgMIP's protocol requires the use of household survey data as input for simulations. This approach, however, allows only for simulations at village level and the presentation of results to policymakers and stakeholders in the form of tables and graphs. Since no household-level survey data was available for Free State Province of South Africa, an alternative framework was developed. The four core AgMIP questions assess the impact of climate change and adaptation on agricultural systems using crop and economic models. Inputs used include remote sensing, crop model inputs (soil, climate and crop management) and enterprise budgets, integrated using a GIS to develop an unmatched case scenario. The Free State is predominantly a semi-arid region covering an area of 129 464 km2 with high rainfall variability, characterized by frequent droughts and flooding. Adding a spatial component to the RIA methodology enables one not only to upscale the modeling to a provincial level but also to map the heterogeneity of the region. Mapping the results of the crop and economic simulations enables one to build an atlas and visualize the outcomes as impact trends.

Maps are especially helpful for policymakers to understand where the largest impact of climate change can be expected, and devise intervention strategies to maintain food production and security.

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WWC1D. Climate Change Impacts on Biophysical Systems #1

***Title*: Simulating the yield response of potato crops to projected climate scenarios for southern Chile using SUBSTOR-POTATO**

Presenter: Patricio Sandaña

Author: Patricio Sandaña[1], Mallory, Ellen[2], Lizana, Carolina[3], Meza, Francisco[4]; García-Gutiérrez, Victor[4]

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[4] Centro Interdisciplinario en Cambio Global UC, Pontifical Catholic University of Chile, Santiago, Chile.

Abstract: The aim of the present study was to assess the yield of potato in southern Chile under projected climate scenarios. The study had two steps, i) calibration and evaluation of the crop simulation model SUBSTOR-Potato (in DSSAT 4.7) with the cultivar Patagonia-INIA and ii) application of the model to assess the impact of climate scenarios on potato yields. Experimental data collected during the 2016-2017, under irrigated conditions, was used to calibrate the genetic coefficients of the cultivar Patagonia-INIA. Tuber yields from 2005-2015 and 12 locations were used to evaluate the model under rainfed conditions. For the model application, a seasonal analysis (30 years of weather) was performed under rainfed conditions including seven climate scenarios (baseline and six future climate scenarios). The six future climate scenarios (30 years of daily data generated for 2040-2070) were the product of three Global Circulation Models (HADCM3, CSIRO, CCSM) and two Representative Circulation Pathways (RCP 4.5 and RCP 8.5). Atmospheric CO2 levels for Baseline, RCP 4.5 and RCP 8.5 were 380, 498 and 572 ppm, respectively. Cultivar coefficients for Patagonia-INIA were identified (G2: 2000, G3: 24.6, PD: 0.8, P2: 0.5, TC: 20). The evaluation of the model showed that, in a wide range of yields (18-110 ton/ha) SUBSTOR-Potato predicted potato yield well for the Patagonia-INIA (0.93 Willmott index, 0.75 R2, 24% nRMSE, and 0.61 modelling efficiency). The analysis of variance for the seasonal analysis reveals that dry tuber yield was significantly ($P<0.001$) affected by the RCPs and Global Circulation Models. On average, RCP 4.5 had no effect on tuber yield, while RCP 8.5 increased tuber yields in 40%. The present studies highlight the necessity to develop strategies to increase recourse use efficiency of potato production systems of Southern Chile.

***Title*: Simulating the yield response of wheat crops to projected climate scenarios for southern Chile**

Presenter: Patricio Sandaña

Author: Patricio Sandaña[1], Quiroz, Jorge[2], Calderini, Daniel F.[2],Meza, Francisco[3]

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Abstract: The aim of the present study was to assess the yield of wheat in southern Chile under projected climate scenarios. The study had two steps, i) calibration and evaluation of the crop simulation model CROPSIM-CERES (in DSSAT 4.7) with the cultivar Pandora-INIA and ii) application of the model to assess the impact of climate scenarios on wheat yields. Experimental data collected during the 2009-2010, under irrigated conditions, was used to calibrate the genetic coefficients of the cultivar Pandora-INIA. Five experiments from 2007-2009 were used to evaluate the model under potential conditions. For the model application, a seasonal analysis (30 years of weather) was performed under rainfed conditions including seven climate scenarios (baseline and six future climate scenarios). The six future climate scenarios (30 years of daily data generated for 2040-2070) were the product of three Global Circulation Models (HADCM3, CSIRO, CCSM) and two Representative Circulation Pathways (RCP 4.5 and RCP 8.5). Atmospheric CO2 levels for Baseline, RCP 4.5 and RCP 8.5 were 380, 498 and 572 ppm, respectively. Cultivar coefficients for Pandora-INIA were identified (P1v: 5, P1D: 25, P5: 630, G1: 24, G2: 53, G3: 3 and PHINT: 98). The evaluation of the model showed that the model predicted reasonably well both above-ground biomass and grain growth for the cultivar Pandora-INIA (d-Stat >0.9). The analysis of variance for the seasonal analysis reveals that grain yield was significantly ($P<0.001$) affected by the scenarios. On average, climate change scenarios will increase grain yields (7-23%). The present studies highlight the necessity to develop strategies to increase recourse use efficiency of wheat production systems of Southern Chile.

***Title*: Global crop production: adaptation options to temperature increase**

Presenter: Sara Minoli

Author: Sara Minoli[1], Elliott, Joshua[2], Ruane, Alex C.[3], Zabel, Florian[4], Dury, Marie[5], Folberth, Christian[6], Francois, Louis[5], Jacquemin, Ingrid[5], Liu, Wenfeng[7], Sakurai, Gen[8], Müller, Christoph[1]

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Abstract: Climate change is already and will continue affecting the productivity of agricultural systems, therefore demanding for adaptation strategies to avoid production losses. Due to the complexity and heterogeneity of crop-climate-soil systems, adaptation options are mostly implemented and evaluated locally. Nevertheless, global-scale estimates are needed because e.g. the efficiency of adaptation measures needs to be discussed in the context of costs and opportunities elsewhere.

Here we present the first systematic study on cropping systems adaptation to temperature increase based on a global gridded crop models (GGCMs) ensemble sensitivity analysis. The models implemented two management options that can alleviate impacts of temperature increase on major grain crops: an adoption of new cultivars to maintain the original growing period and a full irrigation. We assess the effectiveness of these in avoiding yield losses of maize, wheat, rice and soybean.

First results show that, at the global aggregation, irrigation and the unaltered growing period both allow for increasing yields under most warming scenarios, especially when these two strategies are combined. However adaptation effectiveness varies across regions of the global crop land. A cultivar shift has more positive effects in temperate regions than in warmer areas, such as the tropics, where temperature limits crop productivity not only by accelerating crop phenology. Irrigation typically helps to increase yields in water-scarce growing environments, but this is also true for most baseline conditions. Irrigation becomes then a true adaptation measure only if the yield increase is larger under warming than under baseline conditions.

***Title*: Sensitivity analysis of maize grain yield to changes in climate elements, CO_2 and nitrogen fertilizer**

Presenter: Fabiana Bender
Author: Bender, F. D.[1], Sentelhas, P. C.[1]
[1] Department of Biosystems Engineering, ESALQ, University of São Paulo, 13418-900 Piracicaba, Brazil.

Abstract: Currently, Brazil appear as the third largest maize producer in the word, with production obtained in two seasons: 1st and 2nd growing season, both predominantly rainfed. With maize yield being influenced by the interaction of several factors, such as soil, climate and management, future climate projections of increase in temperature and possible reduction of soil water availability should affect the current levels of crop yield. In this sense, two maize crop simulation models (DSSAT-CSM-Ceres Maize and MONICA) were calibrated and evaluated under Brazilian conditions. These models were submitted to a sensitivity analysis, to evaluate their ability to detect changes in air temperature, rainfall, atmospheric CO2 concentration, and nitrogen (N) rates, in order to identify the factors that have the greatest influence on maize grain yield.

Both models presented greater responses on maize grain yield for variations in mean air temperature, with the increasing temperatures impacting yield negatively in both growing

seasons. Increases in rainfall resulted in increases of yield, while reductions led to yield losses. Increasing concentrations of CO2, however, presented little effect on yields. On the other hand, for N doses, both models were sensitive, with yields stabilizing at doses between 120 and 180 kg N ha-1. In general, DSSAT showed to be more sensitive to variations in rainfall and N than MONICA, being more suitable for studies about climate change impact on maize crop.

***Title*: Adjusting Climate Model Bias for Agricultural Impact Assessment: the BAD-JAM project**

Presenter: Stefano Galmarini

Author: S. Galmarini, A.J. Cannon, A. Ceglar, O.B. Christensen, N. de Noblet-Ducoudré, F. Dentener, F. J. Doblas-Reyes, A. Dosio, J. M. Gutierrez, H. Loukos, A. Maiorano, D. Maraun, S. Mcginnis, G. Nikulin, A. Riccio, E. Sanchez, E. Solazzo, A. Toreti, M. Vrac, M. Zampieri

Abstract: The BAD-JAM (Bias ADJustment for Agricultural Models) will be presented. The project foresees that a community of climate modellers will use state-of-the-art B-A methods to produce time series from 1980 to 2100 of EURO-Cordex agro-relevant climate data at specific locations.

We propose the AgMip wheat crop modelling community to use the data to produce wheat-yield projections which will be compared and critically analyzed in the light of the B-A technique used and the difference in the climate data used. The EC/JRC is leading the project, details on the project workings will be presented.

***Title*: Preliminary Results of a Simulation-Based Wheat Yield Forecast Framework for the US Southern Great Plains**

Presenter: Phillip D. Alderman

Author: Alderman, Phillip D., Vaverka, Brandon A.,
Department of Plant and Soil Sciences, Oklahoma State University

Abstract: Much is known about the ecophysiological processes underlying wheat yield and models exist which can integrate these processes to¬†simulate yield well¬†when management, cultivar, soil and weather conditions can be adequately¬†characterized. Characterizing all of these factors accurately¬†remains a challenge at a field scale, which has hitherto¬†limited the scope of¬†simulation analyses across¬†geographic areas. However, the¬†increasing¬†availability of publicly available data (including¬†satellite imagery, soil mapping, and automated¬†weather network data) has greatly improved the feasibility of mesoscale simulation analysis. This presentation will review recent results from the¬†Computational Agricultural Research Lab at Oklahoma State University which characterize¬†spatiotemporal trends in Oklahoma wheat yields using an interface that links gridded weather and soil datasets directly with the DSSAT-CROPSIM-CERES-Wheat crop model. Application of this framework with measured weather data were used to forecast wheat yields starting from 2 to 32 weeks after planting for 19 wheat growing seasons. Measured weather data from years other than the year of forecast were used as representative possible futures for the year of forecast. An overview of the¬†simulation

framework including the model and input¬†data sets used, as well as an analysis of the drivers of yield¬†and sources of uncertainty in forecasts will be presented.

***Title*: InfoCrop DSS aided adaptation to climatic risks in agriculture: Case study from farmers,Äô fields in India**

Presenter: S. Naresh Kumar

Author: S. Naresh Kumar, SK Bandyopadhyay, RN Padaria, AK Singh, Md. Rashid, Md. Wasim and D.N Swaroopa Rani

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Abstract: In a World Bank-GEF project, InfoCrop models were used to quantify the past, current and future climatic risk related loss to productivity of wheat, mustard, maize and soybean in climatically vulnerable villages ie., 11 in Mewat district of Haryana and 13 in Dhar district of Madhya Pradesh. To capture the variability in the potential impacts of climatic risks and adaptation gains in different farms in 24 villages, different management combinations along with varietal variations were input into the model. Simulation analysis indicated that continuation of current management and verities will lead to significant yield loss. For example, wheat experiences early and terminal heat stress during winter season (rabi; Nov.-April) leading to yield loss, while soybean yield performance is strongly correlated to the optimal rainfall and distribution during monsoon season (kharif; June-Oct.). Changing variety and sowing time were found easy to adapt and low-cost technologies to minimize climatic risks. Simulation analysis based short-listed varieties were sown in 24 villages covering about 3500 farms. Yields from different varieties of four crops were compared by taking the samples at 1m2 area. Such introduction of improved varieties enhanced the yield levels in the range of 8-40% under all conditions of management. Percentage of farms falling in the high-yield level group increased. This clearly demonstrated that the outputs from decision support systems such as InfoCrop can be successfully used for implementing adaptation to climatic risks.

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WWC2B: Advanced Computing and Machine Learning Applications for Agriculture

***Title*: Experimental data sets for crop growth model calibration and validation in Latin America**

Presenter: Maurits van den Berg

Author: Condori Al Bruno[1], Beebe, Steve[2], Rebolledo, Maria Camila[2], Marin, F R.[3], Ria, Nestor[4], Rodriguez, Gabriel[5], Guevara, Edgardo[5], Meira, Santiago G.[5], van den Berg, Maurits[6], Rodriguez Baide, Joysee M.[6]

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Abstract: One of the main limitations to the purposeful application of crop growth models, is the lack of ‚Äì or difficulty to access ‚Äì data and information to calibrate and evaluate these models in a regional context.
To overcome this difficulty, relevant information was collected in Latin America and the Caribbean (LAC), for the following crops: potatoes, field beans, rice, wheat, maize, sugarcane, soybean and coffee.
The information collected includes (1) general information on existing modeling studies in LAC; (2) data and meta data from field experiments on crop growth and development, plus associated soil and weather data; (3) Information on crop management at national level; (4) contact details of the researchers responsible for the experiments; and authors of key modelling studies. The results are published in the form of 8 crop-specific reports, which can be downloaded for free. Digital annexes are available on request. Part of the data can be accessed without restriction; in other cases only meta data are given and prospective modellers are directed to contact the owners.
This work was conducted in the framework of EUROCLIMA2, a regional cooperation programme between the EU and 18 countries in LAC, focused on climate change.

***Title*: The AgMIP Impacts Explorer**

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WWC2C: Data Assimilation and Seasonal Forecasting of Agricultural Shocks

***Title*: Assimilating remote sensing observations in a sunflower crop model under uncertainty on soil properties**

Presenter: Ronan Trepos

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WWC2E: Modeling the Causes and Cascading Impacts of Food Shocks

***Title*: Implications of future climate variability on food security: a model-based assessment of climte-induced crop price volatility impacts**

Presenter: Hermann Lotze-Campen

Author: Lotze-Campen, Hermann[1], von Jeetze, Patrick José[2], Rolinski, Susanne[1]
[1] Potsdam Institute for Climate Impact Research (PIK)
[2] Universität Bayreuth

Abstract: Sudden price changes of staple foods that are important to poor people pose a great threat to food security. The objective of the present analysis is to determine changes in the monetary accessibility of calories due to grain price volatility on the global market in a climate change scenario and a reference scenario without climate change and to identify the impacts for the risk of hunger. Distributions of real consumption in 36 countries and a non-linear regression model between total consumption and both the share of food (Engel ratio) and grain consumption are used to predict the real consumption of food and grains.

The changing cost of a food bundle of 1800 kcal serves to approximate changes in the monetary accessibility of calories. Local initial calorie prices are calculated with FAO GIEWS and WFP VAM price data. In order to translate international price changes into domestic prices, price transmission elasticities are taken from the current literature. In the climate change scenario, the strong rise of the international price volatility of maize and rice has significant negative implications for hunger risk in Sub-Saharan Africa, East and South Asia. The number of people that could additionally become prone to hunger risk in our future scenario is more than 36 million people once in four years and more than 176 million people once in twenty years. The increment is substantial when compared to our reference scenario, in which price changes on average showed a positive effect on hunger risk.

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WWC3B: Crop Model Intercomparison in Diverse Systems

***Title*: Comparing the performance of SUBSTOR and CropSyst in five potato varieties under different model calibration strategies**

Presenter: Victor Garcia
Author: Valdivia, Victor[1], Meza, Francisco[2], Sandaña, Patricio[3], Lizama, Carolina[4]
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Abstract: Crop simulation models (CSM) are a fundamental tool to understand the behavior of complex systems, particularly under uncertain and dynamic climate conditions. One of the most severe limitation for its wide use is the difficulty to achieve a proper calibration due to the extensive date requirements (both in terms of quantity and quality).
The massive adoption of automatic weather stations, that are run following reasonable protocols for quality control, the increasing availability of published material regarding crop model parameters and the access of environmental data form different sources such as satellites has opened new avenues for the development of methods to calibrate CSM and use them as tools to predict impacts of climate variability and change, as well as to carry on ex-ante assessments of adaptation strategies.
Here we present a comparison between SUBSTOR and CropSyst that were run a) using default parameters and b) calibrated with minimum yield data. Models were run to analyze the ability to predict yield and water use of five potato varieties grown in southern Chile.

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Additional Presentations

***Title*: "Good practice" and trade-offs in constructing agricultural development indicators for LMICs**

Presenter: C. Leigh Anderson

Author: Alia, Didier[1], Anderson, C. Leigh[1], Biscaye, Pierre[1], Reynolds, Travis[2] and Wineman, Ayala[1]

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Abstract: Modelling agricultural systems in low and middle income countries (LMICs) is constrained by the availability of valid and reliable data. Nationally-representative household surveys represent a rich potential source of data for agricultural modeling, but efforts to produce standardized indicators across multiple instruments have been limited. Each researcher must make a series of decisions in constructing indicators, which depend on indicator definition and the structure of different survey instruments. A group of researchers from the World Bank's LSMS-ISA team, the FAO, the Bill and Melinda Gates Foundation, IRRI, IFPRI, and the Evans School Policy Analysis and Research group (EPAR) met in mid-2017 to discuss "good practice" and common principles for using household survey data to generate standardized estimates of key outcome indicators in agricultural development.

Drawing on multiple waves of panel data from three LSMS-ISA countries (Ethiopia, Nigeria, and Tanzania), EPAR has constructed and publicly posted code for over 40 standardized agricultural development indicators on yield, income, dietary diversity, input use, gender productivity, etc., across 10 survey instruments. We document key choices for cleaning, weighting, interpolating, and constructing these indicators, some of which may have systematic biases built in for some sub-populations or agricultural outputs. To the extent that standardized indicators influence policy or investment decisions and are used in modeling exercises, we plan to share our learning on how to make informed and contextually valid decisions implications of measurement decisions with the goal of supporting more consistent and transparent use of the LSMS-ISA and other LMIC household survey data.

***Title*: The various problems associated into financing livestock production in the Northern Nigeria**

Presenter: Michael Adedotun Oke

Author: Michael Adedotun Oke[1]

[1]Michael Adedotun Oke Foundation

Abstract: Nigerian farmers are finding it difficult to get financial aid that will support the different livestock production chain which is noted in the areas of production; preservation, transportation, marketing and capital needed in the sourcing for the feed, kick starting livestock production and the use of advance technology. Many reasons are adduced for this but the primary reasons are its insufficiency finance and limited sources from which it can be obtained (Ajobo and Oguntade, 1996). The Nigeria Livestock

farmers cannot increase production as a result of aforementioned challenges. This study was conducted to ascertain the problems the livestock smallholder's farmers are having in accessing credit facilities to boost Livestock value chain in the actors. From the projects that comprises the small-scale farmers in Federal Capital Territory- Abuja, Kaduna and Nassrawa State that are into Goat Production. The findings show that must goat farmers that was visited and Interviews are not getting the necessary support from the state Government, due to lack of collateral, short of funds and there are not available plans. But some of the visited poultry farmers were getting some of financial support. Secondary data were used for this study from it the Ajetomobi and Olagunju (2000) report that 54% of farmers obtain credit from esusu (credit) cooperatives against 3% who obtain same from commercial banks in South-western Nigeria. Reasons adduced to this reliance are many, they include dearth of rural banks, distance from loan office, low farm income and time lag between loan application and disbursement from formal sources. Nweze (1994) remarks that objectives of cooperative associations are to pool capital resources, labour for farm work, provision of financial assistance to members in need and community development.

***Title*: Soybean expansion in Europe analyzed with crop niche modeling under current and future climate conditions**

Presenter: Nicolas Guilpart

Author: Guilpart, Nicolas[1], Iizumi, Toshichika[2], Ben Ari,Tamara[3], Makowski, David[3]

[1] AgroParisTech, France

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Abstract: Soybean (Glycine max) is the legume crop experiencing the fastest expansion rate in Europe. According to the Food and Agriculture Organization, its harvested area has increased more than three-fold from 2004 (1.2 Mha) to 2014 (4.5 Mha). This upward trend is likely to be maintained in the next decades for at least three reasons. First, the European demand for soybean far exceeds its current production level. Second, legume crops could contribute to the diversification of cereal-based rotations. Third, an expansion of agricultural land suitable for soybean production is expected in northern Europe due to climate change. So far, no study has been conducted to determine the suitability of European agricultural area for soybean production. Using machine learning techniques, we develop and evaluate a series of niche models relating soybean yield to relevant agro-climatic indices, and then use the most accurate model to assess current and future soybean potential distribution in Europe according to different climate change scenarios. We use two recently published global datasets including historical soybean yields and crop-relevant weather variables (Iizumi et al., 2014a,b), which cover the totality of the world's agricultural land on a 1.125° grid from 1981 to 2010. Models are trained at the global scale, and then applied in Europe to assess soybean potential distribution in 2010, 2050, and 2100, considering contrasted climate change scenarios. Results indicate that European soybean suitable areas extend further out of its actual distribution and that major shifts are likely to occur by the end of the century.

***Title*: Improving Model Design and Development with Stakeholder Engagement: What's in it for Them?**

Presenter: Wendy-Lin Bartels

Author: Bartels, Wendy-Lin[1], Sullivan, Amy[2], Francis, Buhle[3], Ngwenya, Hlamalani[4], Riaz, Farah[5], Anaglo, Jonathan[6], Recha, John[7], Meena, Mohar Singh[8], Wengawenga, Max[9], Arunachalam, Lakshmanan[10], Srigiri, Srinivasa Reddy[11]

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Abstract: Innovative approaches to modeling have created opportunities for meaningful engagement between scientists and a wide range of stakeholders with interests in Climate Change and Climate Smart Agriculture in particular. The AgMIP Regional Integrated Assessment project featured stakeholder engagement to input into model development, better articulate results, take evidence closer to decision makers, and facilitate uptake. This paper highlights experiences and lessons learned from facilitated stakeholder engagement across regional research teams in Africa and Asia. It reflects upon the why, how, and so what of facilitated stakeholder engagement. Findings emerged from a dedicated Stakeholder Unit that had a "stakeholder liaison" embedded within each regional team responsible for planning, facilitating, and documenting engagement. The AgMIP Stakeholder Unit focused on developing the capacity of regional research teams to engage stakeholders throughout their research to increase the utility of research outputs. It encouraged and facilitated scientist-stakeholder engagement to extend beyond data-collection or messaged delivery activities, and emphasized iterative interactions that support research to be regularly refined. True knowledge co-production requires that scientists move beyond interactions designed to coerce, educate, inform or consult stakeholders. Needs assessment is on-going and builds upon or within existing partnerships to strengthen networks and identify entry points for linking evidence to decision making processes. Designing for iteration demands team foresight and associated step-by-step planning, as well as adaptively managing the engagement process.

***Title*: Multimodal ensemble approach to study elevated CO2 effects on wheat productivity**

Presenter: Mukhtar Ahmed

Author: Mukhtar Ahmed[1,2], Claudio O. Stöckle[2], Roger Nelson[2], Stewart Higgins[2]

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Abstract: Elevated carbon-dioxide concentration [eCO2] is key climate change factor affecting plant growth and yield. It results to the enhance photosynthesis and biomass production for C3 crops like wheat by increasing water use efficiency. Since most of the earlier crop modeling work was more focused on studying and quantifying the impact of temperature or combined interactive effect of climatic parameters on crop growth, development and yield and very few studies have focused on carbon dioxide alone. We present here novel multimodal ensemble approach to evaluate the performance of different process based crop models under different level of [eCO2] at variable climatic sites in US Pacific Northwest (PNW) which will help to bring/suggest accuracy in the models response to [eCO2]. APSIM ver. 7.7, CropSyst ver.4.19.06, DSSAT ver. 4.5, EPIC ver. 0810 and STICS ver.8.4 were calibrated to observed data for crop phenology, biomass and yield. After calibration, biomass and grain yield of winter wheat was simulated for [eCO2]. The simulated results by all models showed that [eCO2] resulted to the significant variability among models to simulate biomass at three different sites with highest (44%) production at water stress conditions i.e. Lind while under irrigated conditions (Moses Lake) increase in biomass was 22%. Similarly, average yield increase under water stress among all models from ambient CO2 concentration to 1000 µmol mol-1 was 45% comparatively higher than high rainfall site where it was 34% while under irrigated conditions it remained 22% which was almost 50% less then dryland site (Lind). We concluded from our study that process based crop models have variability in the simulation of crop response to elevated CO2 with greater difference under water-stressed conditions which recommend use of ensembles approach to bring accuracy in the models response to elevated CO2.

***Title*: Agricultural Vulnerability and Adaptation to Climate Change: Understanding and Contextualizing Evidence from Crop Simulations**

Presenter: Malcolm N. Mistry

Author: Mistry Malcolm[1,2], De Cian Enrica[1,2], Sue Wing Ian[3]

[1] Department of Economics, Università Ca' Foscari, Venice, Italy.

[2] Euro-Mediterranean Center on Climate Change (CMCC), Venice, Italy

[3] Department of Earth and Environment, Boston University, MA, U.S.A

Abstract: Global gridded crop models (GGCMs) are the workhorse of assessments of the agricultural impacts of climate change. Yet the changes in crop yields projected by different models in response to the same meteorological forcing can differ substantially. We build on earlier research (Mistry et al., 2017) to elucidate the origins and implications of this divergence, both among GGCMs and within individual GGCM's historical and future simulated yield responses to temperature and precipitation. We use econometric models developed by the empirical climate change impacts literature to statistically characterize the responses of rainfed maize, rice, wheat, and soybean yields simulated by five GGCMs over three epochs: history (1972-2004), mid-century (2033-2065), and end-of-century (2067-2099). The resulting reduced-form emulators of yield response show that, relative to the historical period, future adverse sensitivity to high temperature (> 27 °C) days is attenuated, while sensitivity to low precipitation (< 5 mm) days is

amplified—shifts that we go on to attribute to different adaptation mechanisms within GGCMs. Our emulator approach holds considerable potential as a diagnostic methodology to elucidate uncertainties in the processes simulated by GGCMs, and to support the development of climate change impact inter-comparison exercises within the integrated assessment modelling community.

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Additional Posters:

***Title*: "Efficient Eco- Modern Farm Management as well as Climate Change adaption Western Nepal"**

Presenter: Arjun Pande

Author: Pande Arjun and Pandey Hari

Abstract: Background: Climate change caused increasing pressure on natural resources, resulting in a very fragile ecosystem, declining soil fertility, productivity and general environmental degradation.

Summary: Grihal Laxmi Rice Mill is working past 22 years of rural community as food security not only but also introducing technology of organic farming (Paddy ,Corn& Millet as well as seed processing and refining food decoration system for final use in western Nepal pro-poor farmer ,Pokhara Lekhnat Begnas Country side.

Source:www.glrmnepal.com

Methods: Now we are introducing Modern Eco- farm system (A)Water Collection, (B)Organic Farming ,(C) Food Processing for final use (D)Eco-Tourism(home Stay)

Result: The Climate Change adaption eg:(Eco-Modern Farm) leads greater opportunity of income generation of deprived community.

Conclusion:

Scaling out activities:The project is implementing sustainability that increasing agriculture productivity and income generation, agricultural and food security systems, expansion in near area of the village ,resource arrangement ,utilization .The large number tourist benefited from home stay,this is unique (Innovative)service in our project.

Scaling Up: The technological knowledge for farmer, information ,improved crops varieties and irrigation systems, weather and climate are important factors for agricultural productivity. The delegation of farmer voice and request for subsidy for irrigation and agriculture transportation are major issue to be maintain in local authority, central govt, as well as international bodies focusing for deprived farmer.

***Title*: Overview of the suggestion for the establishment of the Grazing Reserve Bill and the Farmer – Herdsmen Rifts in Nigeria.**

Presenter: Michael Adedotun Foundation

Author: M. A. Oke. Author Affiliation Michael Adedotun Oke Federal Capital Territory Agricultural Development Program and Michael Adedotun Oke Foundation Plot 232 Kaida Road Old Kutunku Gwagwalada.

Abstract: The Law governing the establishment of grazing reserves in Nigeria started in 1965 later in 1978, the land Acts was extended to cover it. In 1988 National policy also earmarked 10 percent of the total National Territory for grazing areas that is 9.8 million hectares of land were earmarked in 1988 for grazing reserves. That figure was later increased to 20 Million hectares. This paper supported the establishment of the Grazing reserve bill, which is the objectives to review different views, after considering the different write up in the daily newspaper of 2015 and 2016 and pictures. There are less than three million hectare gazette grazing areas which cover about three million. We have about 415 grazing areas and grazing reserves. Out of the 415, 141 were gazette. And those 141 reserves gazette cover only about three million hectares of land, it has been damaged by ecology, encroachment. The clashes came as result of the absence of developed grazing reserves and the protection of those reserves, suffered a lot of neglect because the pastoralist livelihood has been frequently undermined by unfriendly policies and laws. The polices of the past administration have given more attention to agronomy and not livestock sector that is what has caused this problems, three million hectares have been destroyed. The forestry units must work effectively to protect the reserves.

***Title*: The marketing of Carrots and the advantage of using Bottle water and used plastic materials in the Federal Capital Territory Abuja Nigeria.**

Presenter: Michael Adedotun Oke

Author: Michael Adedotun Oke

Michael Adedotun Oke Foundation

Abstract: In the Agricultural sectors the used of bottles, plastic, nylons cannot been overemphasize, due to the important of use in respect of the packaging, transportation and marketing strategies wise, which promote effective marketing and adding value to promote profitability and increase sales of an average sellers and encourage buyers and also reducing the weight that will make it easily transported and protect the shelf life of an average crop in the Agricultural sectors.

This paper therefore study a marketers that have being using bottle water in the strategies of prolonging the shelf life of an average carrots. Some of the marketers use the water inside too cool the carrots in which is going to preserve the self-life and some of the nylon are laying down in which they use to displayed some of the products in the markets which promote profitability and encourage more buyers to get close to the customers and various questions were ask from the buyers and sellers. Pictures were taken too support findings. This paper therefore stressed for effective means of marketing and technology development in areas of preservations and prolonging the life shelf of the carrots.

***Title*: Effect of Plant Population Density on Growth and Yield of Artemisia (Artemisia annua L.) at Wondo Genet, Ethiopia**

Presenter: Nigussie Ashenafi

Author: Nigussie Ashenafi, Belisty, Lule and Aynalem, Gebre

Ethiopian Institute of Agricultural Research, Wondo Genet Agriculture Research

Abstract: A field experiment was conducted at wondo genet Agriculture research center under an irrigated condition for two consecutive seasons of 2013 and 2014 in order to determine the effect of intra and inter-row spacing on growth yield and yield component of Artemisia (Artemisia annua L.). Factorial combinations of four intra-rows (40, 60, 80, 100 cm) and four inter-rows plant spacing's (60, 80, 100, 120 cm) were laid out in a randomized complete block design with three replications. Interaction effect of the two factors brought an about a significant variation on aboveground biomass, leaf fresh weight, leaf dry weight and Essential oil yield. However, plant height, number of primary branch per plant and essential oil content were not influenced by the interaction effect. In this study, the maximum aboveground biomass 72605 kg/ha, leaf fresh weight 9510 kg/ha, leaf dry weight 5392.7 kg/ha and Essential oil yield 23.39 kg/ha were recorded due to spacing combination 40cm intra-row and 60cm inter-row spacing's. Therefore, it could be concluded that Artemisia annua could be planted at an optimum spacing of 40 x 60 cm in Wondo genet area to attain maximum leaf fresh weight and essential oil yield.

***Title*: Rangelands resources of South Sudan boast a large number of animals available in significant numbers in all livelihoods zones except the tsetse fly-infested southwesterly Green Belt where only small ruminants may be found. the communities who keep the livestock also grow crops in a closely linked agro-pastoral production system. A sophisticated rhythm of seasonal mobility has sustained a large number of animals in the range, which by recent counts includes about 31 million livestock.**

Thus, not only do the rangelands contribute to the livelihoods of the local inhabitants, they are also the basis of a livestock industry with huge potential for export trading. A number of measures are discussed for sustainable utilization of the range while protecting the environment. Among these are the need to understand, through research, the variability and diversity of the agro-pastoralist system and efficient management of water resources, grazing and animal population. A number of areas requiring enabling policies are pointed out.

Abstract: It is clear that the entire pastoralist in the country totally depends on rangelands resources for their livestock.

***Title*: Analyses of rainfall features and crop water requirements in chickpea production in central rift valley of Ethiopia**

Presenter: Lemma Mengesha

Author: Lemma Mengesha

Abstract: Agriculture is essential for Ethiopian economy while the concerns of climate change impact on agriculture in developing countries have been increasing and this impact could influence agriculture production in a variety of ways. Increasing in temperature and rainfall fluctuation patterns, including the amount of rainfall could adversely affect the productivity of crops. Among the various crops cultivated in the area chickpea productivity is paramount importance. Hence, the study is aimed to characterizing rainfall variability of the study area and its impact on chickpea production. Accordingly, for the purpose of the study, climate data were collected from Debrezeit Agricultural Research Center. Whereas Mann-Kendall test and sen's slope estimator, INISTAT+v.3.37 were

used for analyzing rainfall variability including trends. While, Cropwat 8.0 was used to compute chickpea water requirement. The analysis results showed that the mean annual total rainfall was about 830mm with the growing period ranging from 99 to 215 days. The variability in start of the season for the stations was relatively high as compared to the end of the season. Crop water requirement of chickpea doesn't vary by planting date in the study area and the total water requirement indicated on ranged between 340.6mm and 346.7mm during the growing season. Whereas, the effective rainfall which is the most determinant factor for yield is very variable by planting dates.

***Title*: Forecast of Agricultural Calendar for Maize (Zea Mays) from Global Circulation Model in the Ruzizi Area (DRC)**

Presenter: Agronomist and researcher in Agriculture meteorology. Forecast of seasonal agriculture topics.

Author: Mutalemba Ntole Romain[1], Muhigwa Jean Berckmans[2], Katcho Katcho Karume[3], Mukengere Bagula Espoir[4,5]

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[4] College ofAgricultural and Environmental Sciences (CAES), Makerere University, Uganda

[5] Faculty of Agriculture and Environmental Sciences, Soil Management and Geoinformatic Unit,
Evangelical University in Africa, DR Congo

Abstract: The world is facing several major challenges that regarding answer to the current economic crisis and the development of appropriate strategies to mitigate the adverse effects of climate change. The objective of the study is to identify climate risks for maize and the development of an agricultural calendar from a global circulation model. From meteorological data, an agro-climatic analysis was performed during the period 1995-2013 and a forecast from 2015 to 2045 has been done. The results showed that maize is facing major agro-climatic risks from the shortening of the vegetative growth period consecutive to a screeching halt rains before the end of the rainy season which is one of the major agro-climatic constraints. From predicting Echam-5 model, the agricultural calendar was adjusted to avoid the drop in rainfall observed in October and plan the sowing period at the end of October instead of September.

***Title*: Combining satellite imagery and economic information for environmental and welfare impacts of deforestation reduction in Brazil**

Presenter: Joaquim Bento de Souza

Author: *Ferreira Filho, Joaquim Bento de Souza [1]; Guedes Pinto, Luis Fernando [2]; Faria, Vinicius Guidotti [3], Sparovek, Gerd [4].*

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Abstract: In this study, we combine satellite imagery and economic information to analyze the potential effects of several scenarios of deforestation reduction in Brazil. This data combination allows extending the analysis of deforestation to assess distributive side effects of the policy, using a detailed inter-regional, bottom-up, dynamic general equilibrium model of Brazil, which has as a distinctive factor a transition matrix approach to land use. We build three deforestation scenarios using detailed information on land use in Brazil from satellite imagery that comprises deforestation patterns and land use by state and biome. This information includes agricultural suitability of soil, by biome and state, as well as the classification of land between private and public lands. Results show, for the period under consideration, low aggregate economic losses of reducing deforestation in all scenarios, but those losses are much higher in the agricultural frontier states. Reducing deforestation has also a negative impact on welfare (as measured by household consumption), affecting disproportionately more the poorest households, both at national level and particularly in the frontier regions, both by the income and expenditure composition effects. We conclude that although important from an environmental point of view, those social losses must be taken into account for the policy to get general support in Brazil.

***Title*: Effect of rainfall variability on the crop growing season characteristics: case of smallholder farming in Hwedza district of Zimbabwe**

Presenter: Haroon Shahzad
Author: Mugiyo Hillary and Mhizha Tedious

Abstract: Rain-fed maize production has significantly declined in Zimbabwe especially in semi-arid and arid areas causing food insecurity. Erratic rainfall received associated with mid-season dry spells largely contribute to low and variable maize yields. This study involved a survey of current farmers' cropping practices, analyses of climatic data (daily rainfall and daily minimum and maximum temperature) of Wedza station and simulation of maize yield response to climate change using DSSAT crop growth simulation model. The climatic and maize yield data was analyzed using mean correlation and regression analyses to establish relationships between rainfall characteristics and maize yield in the study area. Survey results showed that maize was the staple food grown by 100% of the farming households while 8.7% also grew sorghum. The survey concludes that 56.2% of the farmers grew short season varieties, 40.2% medium season varieties and 3.6% long season varieties. The result of the correlation analysis of climatic data and maize yield showed that number of rain days had strong positive relationship ($r = 0.7$) with maize yield. Non-significant yield differences ($p > 0.05$) between maize cultivar and planting date criteria were obtained. Highest yields were obtained under the combination of medium season maize cultivar and the DEPTH criterion in all simulations. The range of simulated district average yields of 0.4 t/ha to 1.8 t/ha formed the basis for the development of an operational decision support tool (cropping calendar). The study concludes with the development of a maize cropping calendar for rainfed maize farming in Wedza district. The study recommends the application of climate smart agriculture

techniques such as conservation agriculture, diversification, efficient irrigation technology and improved crop species with shorter growing periods/less moisture consumption as adaptive measures to the changing rainfall pattern within the study area.

***Title*: Wheat response to nitrogen supplication rates and timings**

Presenter: Mohammad Akmal

Author: Khurram Shahzad[1] and Mohammad Akmal[1]

[1] The University of Agriculture Peshawar

Abstract: Wheat (Triticum aestivum L.) is important crop of Pakistan, annually grown on 40% cropped area. Nitrogen (N) is applied higher to wheat than any other nutrient and is consumed only half of the applied quantity. Increased rainfall in spring may increase losses during its reproductive growth. The study, therefore, aims split N application rates and timings focusing wheat grain quality. Field experiment was conducted at Agronomy Research Farm, University of Agriculture Peshawar in 2015-16 in a randomized complete block design, four replications. Seedbed was prepared and wheat (cv. Pakhtunkhwa-15) planted in rows 0.25m. Phosphorus and potassium were applied 90 and 60 kg ha-1, respectively. Nitrogen rates (NAR i.e. 0, 100, 120, 140 and 160 kg ha-1) and timings (NAT1 i.e. 100% at sowing, NAT2 i.e. 50% at sowing + 50% 70 days after sowing (DAS), NAT3 i.e. 25% at sowing, 50% + 70 DAS and 25% 110 DAS and NAT4 i.e. 25% at sowing + 25% 70 DAS and 50% 110 DAS) as treatments revealed no changes in emergence and days to emergence. Nonetheless, days to anthesis and maturity increased by increasing NAR and NAT. Soil total-N (STN) and soil mineral N (SMN) i.e. both NH4 and NO3 were observed the maximum for higher NAR (160 kg ha-1) in three splits (i.e. NAT4). Tiller height and number were maximum for NAR 140 kg ha-1. Total above ground biomass was the highest for NAR 140 kg ha-1 with non-significant change of NAT2 and NAT4. Grain yield was the maximum at 140 kg N ha-1, which did not differ from NAR 160 kg ha-1. The grain yield observed the highest in NAT2 as compared to NAT3 and NAT4. Despite, 1000 grain weight reported higher for NAR 160 followed compared with NAR 140 kg ha-1, no change seen in NAT2 and NAT4. Straw protein content did not differ for NAR and NAT, but did differ for grains protein content. Treatment 140 kg N ha-1 showed the highest grain protein which did not differ from 160 kg ha-1. Interestingly, grain protein was the highest for NAT3 and NAT4 as compared to NAT2.

***Title*: Effect of organic amendments at optimum irrigation level on maize yield, soil carbon dynamics**

Presenter: Haroon Shahzad

Author: Shahzad, Haroon[1], Iqbal, Muhammad[2], Bashir, Safdar[2], Farooq, Muhammad[2]

[1] Arid Zone Research Center, PARC, DI Khan

[2] University of Agriculture, Faisalabad

Abstract: Pakistan is situated in most intensively colonized zone of the world. With passage of time farmer land holdings are decreasing due to increasing population. To feed these increasing mouths the available lands had been cultivated intensively even using brackish water. Use of brackish water for this intensified cultivation is chief cause of soil particles

disintegration resulting into poor structure. To address this problem a series of experiments were conducted using organic amendments and water stress levels as treatments and (FM, PM and MO) were selected through cluster analysis for testing plant behavior and soil on field level maintaining soil water level at 75% AWC. Recommended dosage of mineral fertilizers was applied and maize hybrid Shahnshah was used as test crop. Soil physical characteristics i.e. water stable aggregation (40.68 and 39.91%), soil total organic carbon (12.64 and 12.09 g kg-1), saturated field hydraulic conductivity (27.85 and 27.04 mm hr-1), infiltration rate (26.07 and 25.38 mm hr-1), total porosity (0.49 and 0.48 m3 m-3), plant agronomic i.e. grain yield (9.47 and 9.21 Mg ha-1) and water use efficiency (11.13 and 10.83 kg mm-1 yr-1) were found in farm manure treatment plots that was significantly greater than control but was found statistically at par with other treatments. It was concluded that organic matter addition yields better soil structure that result in proper aeration, water retention, root penetration ultimately achieving yield goals along with saving up to 25% irrigation water as indicated from correlation analysis. According to the results farmers are primarily recommended to use organic manures along with mineral fertilizers which activates indigenous microflora to sustain production, saving soils and water for our next generation.