CLIMATE-SMART Agriculture 2015

Global Science Conference

March 16-18, 2015
Le Corum, Montpellier France

Parallel Session L1
Regional Dimensions

Monday, 16 March 2015

14:00–18:00

Content

ORAL PRESENTATIONS

PARALLEL SESSION L1.1 AFRICA

KEYNOTE PRESENTATIONS

CONTRIBUTED ORAL PRESENTATIONS

[1]CSIRO, 306 Carmody Rd, St Lucia, 4067, Australia
[2]ILRI, Nairobi 00100, Kenya

17:15 Potential for taking climate smart agricultural practices to scale: examples from Sub-Saharan Africa

Tesfaye Kindie[1], Cairns E. Jill[2], Misiko Michael[1], Stirling Clare[3], Abate Tsedeke[4], Prasanna B.M.[4], Mekuria Mulugeta[4]
[1]International Maize and Wheat Improvement Center (CIMMYT), Addis Ababa, Ethiopia
[2]CIMMYT, Harare, Zimbabwe
[3]CIMMYT, London, United Kingdom
[4]CIMMYT, Nairobi, Kenya

PARALLEL SESSION L1.2 AUSTRALASIA

KEYNOTE PRESENTATIONS

14:00 Climate-smart agriculture in South Asia: opportunities and constraints in scaling out

Aggarwal Pramod[1], Kahtri-Chettri Arun[1], Bhaskar Shirsath P.[1], Jat M.L.[2], Joshi P.K.[3]
[1]CGIAR Research Program on Climate Change, Agriculture and Food Security, International Water Management Institute, New Delhi-110012, India
[2]CIMMYT, New Delhi-110012, India
[3]IFPRI, New Delhi-110012, India

14:30 Promotion of climate resiliency for food security in the association of Southeast Asian nations: regional policy making and funding opportunities

Bacudo Imelda
ASEAN-German Programme on Response to Climate Change, GAPCC
GIZ Jakarta

CONTRIBUTED ORAL PRESENTATIONS

16:30 Integrated rice-shrimp as a smart strategy to cope with climate change in the Mekong Delta, Vietnam

Trinh Q. Tu[1], Tran V. Nhuong[2], Phan T. Lam[3]
[1]Research Institute for Aquaculture No.1 (RIA1, Dinh Bang, Tu Son, Bac Ninh, Viet Nam
[2]WorldFish Center (WFC, Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia
[3]Research Institute for Aquaculture No.2 (RIA2), No. 116 Nguyen Dinh Chieu, District 1, Ho Chi Minh City, Viet Nam

16:45 Changing rainfall pattern in Northeast Thailand and implications for cropping systems adaptation

Lacombe Guillaume[1], Polthanee Anan[2], Jintrawet Attachai[3], Trébuil Guy[4]
[1]International Water Management Institute (IWMI), Southeast Asia Regional Office, PO Box 4199, Vientiane, Lao PDR
[2]Department of Plant Science & Agricultural Resources, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand
[3]Center for Agriculture & Resources Systems Research, Faculty of Agriculture, Chiang Mai University, 50000 Chiang Mai, Thailand

[4]Centre de coopération Internationale en Recherche Agronomique pour de Développement (CIRAD), UMR Innovation, 34398 Montpellier Cedex 5, France

17:00 A review of contributions that the System of Rice Intensification (SRI) can make to climate-smart agriculture

Uphoff Norman
SRI-Rice, Cornell University, Ithaca, NY 14853, USA

17:15 Development of climate resilient villages

Sikka A.K.[1], Prasad Y.G.[2], Srinivasarao C.H.[2]
[1]Indian council of agricultural research, New Delhi 110 012, India
[2]ICAR-central research institute for dryland agriculture, Santoshnagar, Hyderabad 500059, India

PARALLEL SESSION L1.3 LATIN AMERICA

KEYNOTE PRESENTATIONS

14:00 Are we adapting to climate change? The case of the Chilean agricultural sector

Aldunce Paulina, Lillo G.
Universidad de Chile, Chile

14:30 Economic valuation of mangrove´s ecosystem services in Gulf of Nicoya, Costa Rica

Arguedas-Marín Maureen, Cifuentes Miguel, Mercado Leida, Bouroncle Claudia
Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), 7170 CATIE, Turrialba, 30501 Costa Rica

CONTRIBUTED ORAL PRESENTATIONS

16:30 The experience in policy dialogue for agriculture and climate change in LAC countries: an overview

Schlaifer Michel[1], Rodriguez Adrián[2], Meza Laura[3]
[1]French Embassy – ECLAC, Santiago, Chile
[2]ECLAC, Agricultural Development Unit, Santiago, Chile
[3]FAO, Santiago, Chile

16:45 Implications of losing the complementariness of gender roles on CSA strategies in the Peruvian Altiplano

Turin Cecilia[1,2], Valdivia Roberto[1], Quiroz Roberto[1,2], Mares Victor[1,2]
[1]International Potato Center (CIP), Global Program on Crop Systems Intensification and Climate Change (CSI-CC), Lima, Peru
[2]CGIAR Research Program on Climate Change, Agriculture and Food Security (CRP CCAFS)

17:00 How do coffee farmers adapt to perceived changes in climate? Evidence from Central America

Saborio-Rodriguez Milagro[1,2], Alpizar Francisco[1], Harvey Celia[3], Martínez Ruth M.[3], Vignola Raffaele[1]
[1]CATIE, Apdo 7170, Turrialba, Costa Rica
[2]University of Costa Rica, 11501, San Pedro de Montes de Oca, Costa Rica
[3]Conservation International, Arlington, VA 22202, USA

17:15 Practices and enabling conditions for climate-smart agriculture: current status in seven countries in Latin America

Bouroncle Claudia[1], Corner-Dolloff Caitlin[2], Halliday Andrew[3], Nowak Andreea[2], Zavariz Beatriz[2], Argote Karolina[2], Baca Maria[4] Fallot Abigail[1,5], Le Coq Jean-Francois[5]

[1]*CATIE-Climate Change and Watershed Program; 30501 Turrialba, Costa Rica*

[2]*CIAT-DAPA, Cali, Colombia*

[3]*CATIE, consultant*

[4]*CIAT-DATA, consultant*

[5]*CIRAD UMR ART-DEV, 34000 Montpellier, France*

PARALLEL SESSION L1.4 EUROPE

KEYNOTE PRESENTATIONS

14:00 EU-funded research & innovation activities in support to Climate Smart Agriculture

Kolar Patrik

Head of Unit "Agri-food Chain", DG Research and Innovation, European Commission, Pl. Rogier 16, BE-1049 Brussels, Belgium

14:30 FACCE-JPI: a European partnering initiative to tackle food security and climate change – one of the greatest societal challenges

Gøtke Niels

Chair of the FACCE-JPI Governing Board

CONTRIBUTED ORAL PRESENTATIONS

16:30 Wheat yield sensitivity to climate change across a European transect for a large ensemble of crop models

Pirttioja Nina[1], Carter Timothy R.[1], Fronzek Stefan[1], Bindi Marco[2], Hoffmann Holger[3], Palosuo Taru[4], Ruiz-Ramos Margarita[5], Tao Fulu[4], Trnka Miroslav[6,7], Acutis Marco[8], Asseng Senthold[9], Baranowski Piotr[10], Basso Bruno[11], Bodin Per[12], Buis Samuel[13], Cammarano Davide[14], Deligios Paola[15], Destain Marie-France[16], Dumont Benjamin[16], Ewert Frank[3], Ferrise Roberto[2], François Louis[16], Gaiser Thomas[3], Hlavinka Petr[6,7], Jacquemin Ingrid[16], Kersebaum Kurt Christian[17], Kollas Chris[17], Krzyszczak Jaromir[10], Lorite Ignacio J.[18], Minet Julien[16], Minguez M. Ines[5], Montesino Manuel[19], Moriondo Marco[20], Müller Christoph[21], Nendel Claas[17], Öztürk Isik[22], Perego Alessia[8], Rodríguez Alfredo[5],. Ruane Alex C.[23,24], Ruget Françoise[13], Sanna Mattia[8], Semenov Mikhail[25], Slawinski Cezary[10], Stratonovitch Pierre[25], Supit Iwan[26], Waha Katharina[21], Wang Enli[27], Wu Lianhai[28], Zhao Zhigan[27,29], Rötter Reimund P.[4]

[1]*Finnish Environment Institute (SYKE), 00250 Helsinki, Finland*

[2]*University of Florence, 50144 Florence, Italy*

[3]*INRES, University of Bonn, 53115 Bonn, Germany*

[4]*Luke Natural Resources Institute, 00790 Helsinki, Finland*

[5]*Universidad Politecnica de Madrid, 28040 Madrid, Spain*

[6]*Institute of Agrosystems and Bioclimatology, Mendel University in Brno, Brno 613 00, Czech Republic*

[7]*Global Change Research Centre AS CR, 603 00 Brno, Czech Republic*

[8]*University of Milan, 20133 Milan, Italy*

[9]*University of Florida, Gainesville, FL 32611, USA*

[10]*Institute of Agrophysics, Polish Academy of Sciences, 20-290 Lublin, Poland*

[11]*Michigan State University, East Lansing, MI 48824, USA*

[12]*Lund University, 223 62 Lund, Sweden*
[13]*INRA, UMR 1114 EMMAH, F-84914 Avignon, France*
[14]*James Hutton Institute, Invergowrie, Dundee, DD2 5DA, Scotland*
[15]*University of Sassari, 07100 Sassari, Italy*
[16]*Université de Liège, 4000 Liège, Belgium*
[17]*Leibniz Centre for Agricultural Landscape Research (ZALF), 15374 Müncheberg, Germany*
[18]*IFAPA Junta de Andalucia, 14004 Córdoba, Spain*
[19]*University of Copenhagen, 2630 Taastrup, Denmark*
[20]*CNR-IBIMET, 50145 Florence, Italy*
[21]*Potsdam Institute for Climate Impact Research, 14473 Potsdam, Germany*
[22]*Aarhus University, 8830 Tjele, Denmark*
[23]*NASA Goddard Institute for Space Studies, New York, NY 10025, USA*
[24]*Columbia University Center for Climate Systems Research, New York, NY 10025, USA*
[25]*Rothamsted Research, Harpenden, Herts, AL5 2JQ, United Kingdom*
[26]*Wageningen University, 6700 AA Wageningen, The Netherlands*
[27]*CSIRO Agriculture Flagship, 2601 Canberra, Australia*
[28]*Rothamsted Research, North Wyke, Okehampton EX20 2SB, United Kingdom*
[29]*China Agricultural University, 100094 Beijing, China*

16:45 Economic assessment of greenhouse gas mitigation on livestock farms

Eory Vera[1], Faverdin Philippe[2], O'Brien Donal[3]
[1]*Scotland's Rural College (SRUC), Land Economy, Environment & Society, EH9 3JG, Edinburgh, United Kingdom*
[2]*INRA, UMR Physiologie, Environnement et Génétique pour l'Animal et les Systèmes d'Élevage, F-35000 Rennes, France*
[3]*Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co Cork, Ireland*

17:00 Agricultural adaptation to climate change in the European Union

Trapp Natalie, Schneider Uwe A.
Universität Hamburg, KlimaCampus, Research Unit Sustainability and Global Change, Grindelberg 5, 20144 Hamburg, Germany

17:15 Legume supported cropping systems for Europe (Legume Futures)

Rees R.M.[1], Stoddard, F.[2], Iannetta, P.[3], Williams, M.[4], Zander, P.[5], Murphy-Bokern, D.[6], Topp, C.F.E.[1], Watson, C.A.[1]
[1]*Scotland's Rural College, Edinburgh EH9 3JG, United Kingdom*
[2]*Department of Agricultural Sciences, 00014 University of Helsinki, Finland*
[3]*James Hutton Institute, Dundee, United Kingdom*
[4]*Department of Botany, Trinity College Dublin, Ireland*
[5]*Leibniz Centre for Agricultural Landscape Research (ZALF), 15374 Müncheberg, Germany*
[6]*Lohne, 49393 Germany*

PARALLEL SESSION L1.5 NORTH AMERICA

KEYNOTE PRESENTATIONS

14:00 Building climate smart, sustainable, intensive agriculture for the 21st century and beyond

Walthall Charles[1], Hatfield Jerry[2], Schneider Sally[3], Boggess Mark[4]

[1]National Program Leader, Natural Resources & Sustainable Agriculture Systems Research
[2]Laboratory Director & Supervisory Plant Physiologist, National Laboratory for Agriculture & Environment
[3]Deputy Administrator, Natural Resources & Sustainable Agriculture Systems Research
[4]Center Director, U.S. Dairy Forage Research Center, USDA Agricultural Research Service

14:30 Scientific article summarizing the 2013 CSA Global Science Conference in North America

Jackson Louise E.[1], Steenwerth K.L.[2]
[1]Department of Land, Air and Water Resources, University of California Davis, USA
[2]Crops Pathology and Genetics Research Unit, Agricultural Research Service, United States Department of Agriculture (ARS/USDA), USA

CONTRIBUTED ORAL PRESENTATIONS

16:30 The 4-R nutrient stewardship and its role in climate smart agriculture

Khosla Raj, Longchamps Louis, Reich R.
Department of Soil & Crop Sciences, Colorado State University, Fort Collins, CO, USA

16:45 From climate variability to climate change: building adaptive capacity among row crop farmers in the Southeastern USA

Ortiz Brenda V.[1], Fraisse Clyde[2], Dourte Daniel[2], Bartels Wendy-Lin[2], Zierden David[3], Knox Pam[4], Risse Mark[4], Vellidis George[4], Templeton Scott[5], Thomas Michel[6]
[1]Auburn University, Crop, Soil, and Environmental Sciences Department, 36849, Auburn, Alabama, USA
[2]University of Florida, Biological and Agricultural Engineering Department, Gainesville, Florida, USA
[3]Florida State University, Center for Ocean-Atmospheric Prediction Studies (COAPS), 32310, Tallahassee, Florida, USA
[4]University of Georgia, Crop and Soil Sciences Department, 30602, Athens, Georgia, USA
[5]Clemson University, Department of Economics, 29631, Clemson, South Carolina, USA
[6]Florida A&M University, Department of Agribusiness, 32307, Tallahassee, Florida, USA

17:00 Climate-Smart Agriculture and Water Management in California

Sandoval Solis Samuel
University of California, Davis One Shields Avenue Davis, California - CA 95616, USA

17:15 Dealing with climate and yield variability: the role of precision agricultural technologies and crop models

Basso Bruno[1], Robertson G. Philip[2], Hatfield Jerry[3]
[1]Department of Geological Sciences and W.K. Kellogg Biological Station, Michigan State University East Lansing, Michigan 48823, USA
[2]Department of Plant, Soil and Microbial Sciences and W.K. Kellogg Biological Station, Michigan State University East Lansing, Michigan 48823, USA
[3]National Laboratory for Agriculture and Environment, Ames, Iowa 50011, USA

POSTER SESSION 1

L1.1 AFRICA

1. Is conservation agriculture a climate-smart option for smallholders in sub-Saharan Africa?

Bruelle Guillaume[1], Naudin Krishna[2], Scopel Eric[2], Corbeels Marc[2], Torquebiau Emmanuel[2], Penot Eric[3], Rabeharisoa Lilia[4], Mapfumo Paul[5], Tittonell Pablo[6]
[1]*FOFIFA, DP SPAD, 101, Antananarivo, Madagascar*
[2]*CIRAD, UPR AÏDA, 34398, Montpellier, France*
[3]*CIRAD, UMR Innovation, 34398, Montpellier, France*
[4]*Université d'Antananarivo, LRI, 101, Antananarivo, Madagascar*
[5]*University of Zimbabwe, SOFECSA, 00263, Harare, Zimbabwe*
[6]*Wageningen University, FSE, 6708 PB, Wageningen, the Netherlands*

2. From time uncertainties to climate-smart agriculture in the Sudano-Sahelian zone of Cameroon

Fofiri Nzossie Eric Joël[1], Bring[2], Temple Ludovic[3], Wakponou Anselme[4]
[1]*Département de géographie, Université de Ngaoundéré BP 454, Cameroon*
[2]*Département de géographie, Université de Ngaoundéré BP 454, Cameroon*
[3]*Cirad, UMR Innovation, B15, 73 rue JF. Breton 34398 Montpellier, France*
[4]*Département de géographie, Université de Ngaoundéré, BP 454, Cameroon*

3. Feeding Ethiopia in changing context: from diagnosis to exploration of climate smart options

Mezegebu Getnet[1,2,3], Martin van Ittersum[1], Katrien Descheemaeker[1], Huib Hengsdijk[2]
[1]*Plant Production Systems group, Wageningen University, P.O. Box 430, 6700 AK Wageningen, the Netherlands*
[2]*Plant Research International, Wageningen University and Research, P.O. Box 616, 6700 AP Wageningen, the Netherlands*
[3]*Ethiopian Institute of Agricultural Research, Melkassa Research Centre, P.O. Box 436, Nazareth, Ethiopia*

4. Macroalgae as biostimulants of growth and enhance tolerance to Moroccan wheat plants cultivated under salt stress

Latique Salma, Chernane Halima, Mansouri Mounir, El Kaoua Mimoun
Cadi Ayyad University /Department of Biology, Laboratory of Biotechnology, Valorization and Protection of Agro-Resources, Marrakech, Morocco

5. Improving the resilience of fishery stakeholders to the climate change effects. Case of Saint-Louis, Senegal

Diallo Aminata[1], Sarr Benoit[2], Thiao Djiga[3], Sall Moussa[4]
[1]*Centre for Oceanographic Research Dakar,Thiaroye, Senegal (up to october 2O14), Fann Résidence, Dakar, Senegal*
[2]*Agro meteorologist Engineer and Coordinator of Master Climate Change and Sustainable Development Program, Scientific Coordinator of the Global Alliance against Climate Change Project (Regional Centre AGRYMET), Niger*
[3] *Researcher and statistician at the Centre for Oceanographic Research Dakar / Thiaroye, Senegal*
[4] *Regional Coordinator of the MOLOA to the Ecological Monitoring Centre*

6. Comparative assessment of maize, finger millet and sorghum for household food security under increasing climatic risk

Rurinda Jairos[1,2,3], Mapfumo Paul[2,3], van Wijk T. Mark[1,4], Mtambanengwe Florence[2,3], Rufino C. Mariana[4], Chikowo Regis[2,3], Giller E. Kenneth[1]

[1]Plant Production Systems, Wageningen University, P.O. Box 430, 6700AK Wageningen, The Netherlands
[2]Department of Soil Science and Agricultural Engineering, University of Zimbabwe, P.O. Box MP167, Mount Pleasant, Harare, Zimbabwe
[3]Soil Fertility Consortium for Southern Africa (SOFECSA), CIMMYT, Southern Africa, P.O. Box MP 163, Mount Pleasant, Harare, Zimbabwe
[4]International Livestock Research Institute (ILRI), Box 30709, Nairobi 00100, Kenya

7. Choice and risks of management strategies of farming calendar: application to corn production in Southern Benin

Alle C. S. Ulrich[1], Baron Christian[2], Guibert Hervé[2], Agbossou K. Euloge[1], Afouda A. Abel[1]
[1]Université d'Abomey - Calavi, Republic of Benin
[2]CIRAD, France

8. Land cover changes along tropical highland agroforestry systems: call for an improved climate adaptation

Matokeo Arbogast[1], Lyimo James[1], Lelong Camille[2], Majule Amos[1], Masao Catherine[1], Mathé Pierre-Etienne[3], Vaast Philippe[4], Williamson David[4,5]
[1]Institute of Resource Assessment, University of Dar es Salaam, P.o.Box 35 097 Dar es Salaam, Tanzania
[2]Cirad-TETIS, Maison de la Télédétection, 34093 Montpellier Cedex 5, France
[3]CEREGE, Aix-Marseille Université, BP 80, 13 545 Aix-en-Provence cedex 04, France
[4]CRAF, p.o. box 30 677-00100 Nairobi, Kenya
[5]Eco&Sols, Montpellier SupAgro-Cirad-INRA-IRD, 34060 Montpellier cedex 2, France
[6]LOCEAN, Université Pierre et Marie Curie-IRD-CNRS-MNHN, Centre IRD France Nord, 93 143 Bondy cedex, France

9. Ecological intensification for a climate smart agriculture: applications from Senegal and Burkina Faso

Masse Dominique[1], Ndour-Badiane Ndèye Yacine[2], Hien Edmond[3], Akpo Léonard-Elie[4], Diatta Sekouna[4], Bilgo Ablassé[5], Hien Victor[5], Diédhiou Ibrahima[6], Ndiaye-Cissé Mame Farma[2], Tall Diouf Laure[2], Ndienor Moussa[2], Founoune Mboup Hassna[3], Feder Frédéric[7], Médoc Jean-Michel[7], Lardy Lydie[1], Assigbetsé Komi[1], Cournac Laurent[1]
[1]LMI IESOL, UMR Eco&Sols, Institut de Recherche pour le Développement, BP 1386 Centre ISRA IRD Bel Air, Dakar, Senegal
[2]LMI IESOL, LNRPV, Institut Sénégalais de Recherche Agricole, Centre ISRA IRD Bel Air, Dakar, Senegal
[3]LMI IESOL, UFR SVT, Université de Ouagadougou, Ouagadougou, Burkina Faso
[4]LMI IESOL, Département de Biologie Végétale, Université Cheikh Anta Diop, Dakar, Senegal
[5]LMI IESOL, Département GRN/SP, Institut Nationale de l'Environnement et de la Recherche Agricole. Ouagadougou, Burkina Faso
[6]LMI IESOL, Ecole Nationale des Sciences Agronomiques, Université de Thiès, Thiès, Senegal
[7]LMI IESOL, UPR Recyclage et risques, CIRAD, Dakar, Senegal

10. Incorporating climate change into agricultural research and advisory services in Africa

Lamboll Richard[1], Morton John[1], Kisauzi Dan[2], Ohiomoba Ifidon[3], Demby Dady[3], Mangheni Margaret[4], Moumouni Ismail[5], Parkinson Verona[6], Suale David[7], Nelson Valerie[1], Quan Julian[1]
[1]Natural resources Institute, University of Greenwich, ME4 4TB, United Kingdom
[2]African Forum for Agricultural Advisory Services (AFAAS), P.O. Box 34624, Kampala, Uganda
[3]The Forum for Agricultural Research in Africa (FARA), 12 Anmeda Street, Roman Ridge, Accra, Ghana
[4]Agricultural Extension/ Education Department, Makerere University, P.O. Box, 7062, Kampala, Uganda
[5]University of Parakou, BP 123, Parakou, Benin
[6]AGEMA Consultancy Services, C.P 437, Quelimane, Mozambique
[7]Independent consultant and AFAAS Sierra Leone, P O Box 7, Freetown, Sierra Leone

11. Developing community-based climate smart agriculture through participatory action research in West Africa: lesson learnt

Akponikpe P.B. Irenikatche[1], Bayala Jules[2], Zougmore Robert[3]

[1]*Université de Parakou (UP), Faculté d'Agronomie (FA), Unit of Environmental Soil Physics and Hydraulics (ESPH), 03 BP 351 Université, Parakou, Bénin*

[2]*World Agroforestry Centre, West Africa and Central Regional Office - Sahel Node, BP E5118, Bamako, Mali*

[3]*CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), ICRISAT Bamako, BP 320 Bamako, Mali*

12. Indigenous Climate Smart Agriculture (iCSA); local knowledge pool from urban vegetable farmers

Kweku Oduro Koranteng

Dept. of Public Admin and Health Services, Uni of Ghana Business Sch., Ghana

13. Mitigation of climate change through soil organic carbon sequestration in smallholder farming systems of Zimbabwe

Mujuru Lizzie[1], Mureva Admore[1], Velthorst Eef, J.[2], Hoosbeek Marcel R.[2]

[1]*Bindura University of Science Education, Dept. of Environmental Science, P. bag 1020, Bindura, Zimbabwe*

[2]*Wageningen University, Dept. of Environmental Sciences, Earth System Science, P.O. Box 47, 6700 AA Wageningen, The Netherlands*

14. Climate-smart intensification of West-Africa's cocoa systems

van Asten Piet[1], Jassogne Laurence[1], Vaast Philippe[2] Laderach Peter[3], Schroth Götz[4], Lundy Mark[3], Asare Richard[5], Muilerman Sander[5], Ruf R.[6], Snoeck Didier[6], Koko Louis[7], Anim-Kwapong Gilbert[8], Rossing Walter[9], Gockwoski James[5], Giller Ken[9], Six Johan[10], Vanlauwe Bernard[11]

[1]*IITA, Kampala, Uganda*

[2]*ICRAF, Nairobi, Kenya*

[3]*CIAT, Cali, Colombia*

[4]*Rainforest Alliance, Wageningen, the Netherlands*

[5]*IITA, Accra, Ghana*

[6]*CIRAD, Montpellier, France*

[7]*CNRA, Abidjan, Cote d'Ivoire*

[8]*CRIG, Kumasi, Ghana*

[9]*WUR, Wageningen, the Netherlands*

[10]*ETH, Zurich, Switzerland*

[11]*IITA, Nairobi, Kenya*

15. Effect of oil and addition of enzymes on fibre digestion, methane production and performance of sheep

Booyse Maruzaan, Hassen Abubeker

Department of Animal and Wildlife Sciences, University of Pretoria, Pretoria 0002, South Africa

16. Drought and adaptation strategies of rural maize-legume farmers in Kenya and Tanzania

Muricho Geoffrey[1], Tongruksawattana Songporne[1], Mutheu Judith[2]

[1]*International Maize and Wheat Improvement Center (CIMMYT), Nairobi, Kenya*

[2]*African Economic Research Consortium, Nairobi, Kenya*

17. Biochar as an opportunity for climate-smart agriculture in small-holder farming systems in Kenya

Sundberg Cecilia[1], Karltun Erik[1], Mahmoud Yahia[2], Nyberg Gert[1], Njenga Mary[3], Roobroeck Dries[4], Röing de Nowina Kristina[4]

[1]*Swedish University of Agricultural Sciences 750 07 Uppsala Sweden*

[2]*Lund University, Sweden*

[3]World Agroforestry Centre, ICRAF, UN Avenue, Nairobi, Kenya
[4]International Institute of Trobical Agriculture (IITA) Nairobi, Kenya

18. Farmers' perceptions of rainfall and agronomic trends in Allada plateau in southern Benin

Alle Cayossi S. Ulrich[1], Guibert Hervé[2], Baron Christian[2], Agbossou Euloge K.[1], Afouda Abel A.[1]
[1]*Université d'Abomey Calavi, Bénin*
[2]*CIRAD, France*

19. Climate and maize storage losses from insect pests in East and Southern Africa

De Groote Hugo, Gitonga Zachary, Sonder Kai, Mugo Stephen, Tefera Tadele
CIMMYT, PO Box 1041-00621 Nairobi, Kenya

20. Maize-based farm household typology and vulnerability to climate shocks in Kenya

Tongruksawattana Songporne[1], Lopez-Ridaura Santiago[2], Tesfaye Kindie[3], Frelat Romain[2], Gitonga Zachary[1]
[1]*International Maize and Wheat Improvement Center (CIMMYT), Nairobi, Kenya*
[2]*International Maize and Wheat Improvement Center (CIMMYT), El Batan, Mexico*
[3]*International Maize and Wheat Improvement Center (CIMMYT), Addis Ababa, Ethiopia*

21. Changing crop practices to address climate related risks among rural farmers in Nyando, western Kenya

Recha John, Kinyangi James, Radeny Maren
CGIAR Research Program on Climate Change, Agriculture and Food Security, East Africa Region, International Livestock Research Institute, P. O. Box 30709 - 00100 Nairobi, Kenya

22. Establishing an operational dialogue between researchers and decision-makers for adaptation to climatic changes in Mali

Sogoba Bougouna[1], Ba Allassane[2], Zougmore Robert[3], Samake Oumar B.[4]
[1]*ONG AMEDD, BP: 212, Koutiala, Mali*
[2]*Conseiller spécial du premier ministre du Mali ; BP: 2357, Bamako, Mali*
[3]*ICRISAT, BP:320 Bamako, Mali*
[4]*ONG AMEDD, BP:212, Koutiala, Mali*

23. Women involvement in agricultural water management: example from supplemental irrigation in the Burkinabe Sahel

Bologo/Traoré Maïmouna[1], Fossi Sévère[2], Zougouri Sita[3], Bado Eulalie[1,3]
[1]*International Institute for Water and Environmental Engineering (2iE), Department of Managerial Sciences, 00226, Ouagadougou, Burkina Faso*
[2]*International Institute for Water and Environmental Engineering (2iE), Department of Hydraulics and Sanitation, 00226, Ouagadougou, Burkina Faso*
[3]*University of Ouagadougou, Department of Sociology, 00226, Ouagadougou, Burkina Faso*

24. Assessing potential climate change impacts in smallholder systems in Burkina Faso

Medina Hidalgo Daniela[1,] Herrero Mario[1], De Voil P.[3], Douxchamps Sabine[4], Thornton Phillip[6], Van Wijk Mark[5], Rodriguez Daniel[3], Prestwidge Di[1], Henderson B.[1], Rigolot Cyrille[1,2]
[1]*Commonwealth Scientific and Industrial Research Organization, St Lucia, QLD 4067, Australia*
[2]*INRA, UMR 1273 Metafort, F-63122 Saint Genes Champanelle, France*
[3]*University of Queensland, Queensland Alliance for Agriculture and Food Innovation (QAAFI), Toowoomba, Australia*
[4]*International Livestock Research Institute (ILRI), Ouagadougou, Burkina Faso*

[5]International Livestock Research Institute (ILRI), PO Box 30709-00100, Nairobi, Kenya
[6]CGIAR Research Programme on Climate Change, Agriculture and Food Security, (CCAFS), PO Box 30709-00100, Nairobi, Kenya

25. Micro-level appraisal of success stories of pro-poor climate adaptation and mitigation field experiences

Bockel Louis[1], Bernoux Martial[2], Zingg Felix[1], Grewer Uwe[1], Chotte Jean-Luc[2]
[1]Agriculture Development Economics Division (ESA) FAO Via delle Terme di Caracalla, 00153 Roma, Italy
[2]UMR Eco&Sols IRD, 2 Place Viala, 34060 Montpellier, France

26. Economic analysis of effect of flood on income distribution among farmers in Edo State, Nigeria

Osasogie Daniel Izevbuwa[1], Alabi Reuben Adeolu[2]
Department of Agricultural Economics and Extension, Ambrose Alli University, PMB 14, Ekpoma, Edo State, Nigeria

27. Identifying farm-level hotspots to target greenhouse gas measurements in smallholder crop-livestock systems

Ortiz Gonzalo Daniel[1], Rosenstock Todd S.[2], Vaast Philippe[3], Oelofse Myles[1], de Neergaard Andreas[1], Albrecht Alain[3]
[1]University of Copenhagen, Department of Plant and Environmental Sciences, Thorvaldsensvej 40, 1871 Frederiksberg C, Denmark
[2]World Agroforestry Centre ICRAF, East & Southern Africa Regional Programme, United Nations Avenue, GigiriPO Box 30677, Nairobi, 00100, Kenya
[3]Affiliation of author 3 and 6. CIRAD, UMR 210 Eco&Sols - Batiment 122 Place Viala F-34060 Montpellier cedex 2, France

28. Intensification test on maize production in the Sudano-Sahelian zone: techniques, soils, climate and economic conditions

Guibert Hervé[1], Olina Bassala Jean-Paul[2], Vunyingah Michael[2]
[1]Cirad, UPR Aïda, F-34000, Montpellier, France
[2]Irad, Po Box 415, Garoua, Cameroon

29. Profile of climate smart agricultural technologies in the dry Guinea savannah and forest zones in Ghana

Botchway V. A. [1], Karbo N.[1], Zougmore R.[2], Sam K. O.[1]
[1]CSIR-Animal Research Institute, Accra, Ghana
[2]ICRISAT, Bamako, Mali

30. Contribution to the valorisation of forest species potentialities in promoting climate smart agriculture in Madagascar

Andriampiolazana Manony[1], Randevoson Finaritra[1], Rajoelison Gabrielle[1], Cailleau Guillaume[2], Verrecchia Eric[2], Razakamanarivo Herintsitohaina[3]
[1]Département des Eaux et Forêts, Ecole Supérieure des Sciences Agronomiques- Université d'Antananarivo, BP 175 - Tanà 101 Madagascar
[2]Faculté des géosciences et de l'environnement, Institut des dynamiques de la surface terrestre - Université de Lausanne, Quartier UNIL-Mouline, CH-1015 Lausanne, Switzerland
[3]Laboratoire des Radioisotopes - Université d'Antananarivo, Route d'Andraisoro BP 3383, Madagascar

31. Optimizing rhizosphere microbiology and hydrology of shrub-intercropping for buffering climate change in the Sahel

Dick Richard[1], Diédhiou Ibrahima[2], Dossa Ekwe[3] , Kizito Fred[4], Chapuis-Lardya Lydie[5,6], Badiane Ndourb Yacine[7], Debenport Spencer J.[1], McSpadden Gardener Brian B.[1], Assigbetsea Komi B.[5,6], Bright Matthew[1], Schreiner Paul[8], Founoune Mboupc Hassna[7], Bayala Roger[7], Diallo Ndeye Hélène[7]

[1]*The Ohio State University, Columbus, Ohio, USA*

[2]*Université de Thiès, Thiès, Senegal*

[3]*International Fertilizer Development Corporation, Lome, Togo*

[4]*International Water Management Institute, Accra, Ghana*

[5]*Institut de Recherche pour le Développement, IRD, UMR Eco&Sols, Dakar, Senegal*

[6]*LMI IESOL Intensification Ecologique des Sols cultivés en Afrique de l'Ouest, Dakar, Senegal*

[7]*Institut Sénégalais de Recherches Agricoles, ISRA Dakar, Senegal*

[8]*United States Department of Agriculture, Agricultural Research Service, Corvallis, Oregon, USA*

32. Native shrub management on soil nematofauna: optimization and adaptation to climate change of Sahelian agroecosystems

Diakhate Sidy[1,2], Mboup Hassna Founoune[2], Ndour Yacine Badiane[1,2], Chapuis-Lardy Lydie[3], Dick Richard P.[4]

[1]*Institut Sénégalais de Recherches Agricoles, ISRA-LNRPV Laboratoire National de Recherches sur les Productions Végétales, Dakar, Senegal*

[2]*LMI IESOL Intensification Ecologique des Sols cultivés en Afrique de l'Ouest, Dakar, Senegal*

[3]*Institut de Recherche pour le Développement, IRD, UMR Eco&Sols, Place Viala Bat 212 Montpellier, France*

[4]*The Ohio State University, Columbus, Ohio, USA*

33. Optimal rice cropping systems under uncertainty: case of West Africa Rice Sector Development Hubs

Lokossou Jourdain[1], Arouna Aminou[2], Atacolodjou Annick[3]

[1]*University of Abomey-Calavi, Benin*

[2]*AfricaRice Centre, Benin*

[3]*Catholic University of West Africa, Benin*

34. Effects of intensification of maize and rice production in Tanzania on productivity and environmental impacts

Brentrup Frank, Mtengeti Ephraim

Yara International ASA, Research Centre Hanninghof, Hanninghof 35, 48249 Duelmen, Germany

35. Small farming food versus ethanol sugarcane: global constraints and local opportunities for irrigation in Ghana

Dumas Patrice[1], Brunelle Thierry[1], Souty François[1], Bibas Ruben[1], Méjean Aurélie[1], Lazar Attila[2], Black Emily[2], Vianna Cuadra Santiago[3], Vidale Pier Luigi[2], Verhoef Anna[2], Wade Andrew[2]

[1]*CIRED (CIRAD, ENPC, CNRS, EHESS, AgroParisTech), Nogent-sur-Marne, France*

[2]*University of Reading, Reading, United Kingdom*

[3]*EMBRAPA, Brazil*

36. Nutritive quality of dominant forage species in response to simulated drought in sub-tropical native pasture

Talore D.G.[1], Hassen A.[1], Tesfamariam E.H.[2]

[1]*Department of Animal and Wildlife Sciences, University of Pretoria, Private bag 0083, South Africa*

[2]*Department of Plant Production and Soil Sciences, University of Pretoria, Private bag 0002, Pretoria, South Africa*

37. Variability of effects of compost on nodulation, N acquisition and yield of cowpea in sub-Saharan areas of Burkina Faso

Zongo Koulibi Fidèle[1], Clermont-Dauphin Cathy[2], Drevon Jean Jacques[3], Blavet Didier[2], Masse Domunique[2], Hien Edmond[1,2]

[1]*UO, Université de Ouagadougou, UFR-SVT, 03 BP 7021, Ouagadougou, Burkina Faso*

[2]*IRD, UMR Eco&Sols, 1 Place Viala, Montpellier, France*

[3]*INRA, Eco&Sols, 1 Place Viala, Montpellier, France*

38. Potentials of medicinal plants extracts on digestibility, in vitro methane gas production of Eragrostis curvula forage

Akanmu Abiodun Mayowa, Hassen Abubeker

Department of Animal and Wildlife Sciences, University of Pretoria, Pretoria 0002, South Africa

39. Food security patterns at farm household level: key drivers and options for climate-smart agricultural interventions

Wichern Jannike[1], Descheemaeker Katrien[1], van Wijk Mark[2], Giller Ken[1]

[1]*Wageningen UR, Plant Production Systems, 6708 PB Wageningen, The Netherlands*

[2]*International Livestock Research Institute, 00100 Nairobi, Kenya*

40. Analysis of the impact of climate changes in the last thirty years on the second generation of cocoa in Côte d'Ivoire

Kassin Koffi Emmanuel[1], Yao Guy Fernand[1], Diedhiou Arona[2], Koko Louis Kan Anselme[3], Assiri Assiri Alexis[3], Kouamé Brou[1], Konaré Abdourahamane[4], Kouassi Koffi Nazaire[5], Yoro Gballou René[1]

[1]*National Center of Agronomic Research (CNRA), Central Laboratory of Soil, Water and Plants, Sustainable Management of Soil and Water Control Program, 01 633 BP 01 Bouaké, Ivory Coast*

[2]*Institute of Research for Development (IRD), University of Grenoble Alpes, LTHE, BP 53, 38041 Grenoble Cedex 9, France*

[3]*National Center of Agronomic Research (CNRA), Cocoa Program, BP 808 Divo, Ivory Coast*

[4]*Félix Houphouët-Boigny University of Cocody, UFR SSMT, Laboratory of Atmospheric Physics and Fluid Mechanics (LAPA-MF), 22 BP 582 22 Abidjan, Ivory Coast*

[5]*National Center of Agronomic Research (CNRA), Central Laboratory of Biotechnology (LCB), 01 BP 1740 Abidjan 01, Ivory Coast*

41. Carbon footprinting of the Irish potato production systems in Zimbabwe

Svubure Oniward[1,2], Struik Paul C.[2], Haverkort Anton J.[3,4], Steyn Martin J.[4]

[1]*Chinhoyi University of Technology, Department of Irrigation and Water Engineering, PB 7724, Chinhoyi, Zimbabwe*

[2]*Centre for Crop Systems Analysis, Wageningen University and Research Centre, 6700 AK Wageningen, the Netherlands*

[3]*Plant Research International, Wageningen University and Research Centre, 6700 AP, Wageningen, the Netherlands*

[4]*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa*

42. Farmers' access to agrometeorological services in Ido local government area of Oyo state, Nigeria

Ewebiyi I.O.[1], Olayemi O.O.[2], Osikabor B.[2], Aluko, O.J.[2], Samuel O.F.[2]

[1]*Department of Agricultural Science, College of Science and Information Technology, Tai- Solarin University of Education, Ijebu ode, Ogun state, Nigeria*

[2]*Department of Agricultural Extension and Management, Federal College of Forestry, Forestry Research Institute of Nigeria, Ibadan, Oyo state, Nigeria*

43. Impact of dry-wet cycles on carbon mineralization of tropical soils

Yemadje Pierrot Lionel[1,2], Guibert Hervé[1], Bernoux Martial[2], Deleporte Philippe[3], Chevallier Tiphaine[2]
[1]*CIRAD, UPR AIDA, F-34398 Montpellier, France*
[2]*IRD, UMR Eco&Sols, Campus SupAgro Bâtiment 12, 2 place Viala, 34060 Montpellier Cedex 2, France*
[3]*CIRAD, UMR Eco&Sols, Campus SupAgro Bâtiment 12, 2 place Viala, 34060 Montpellier Cedex 2, France*

44. Impact of climate change and desertification on agriculture and food security in Côte d'Ivoire

Kassin Koffi Emmanuel[1], Yao Guy Fernand[1], Diedhiou Arona[2], Kouamé Brou[1], Konaré Abdourahamane[3], Kouassi Koffi Nazaire[4], Yoro Gballou René[1]
[1]*National Center of Agronomic Research (CNRA), Central Laboratory of Soil, Water and Plants, Sustainable Management of Soil and Water Control Program, 01 633 BP 01 Bouaké, Ivory Coast*
[2]*Institut de Recherche pour le Développement (IRD), Université de Grenoble Alpes, LTHE, BP 53, 38041, Grenoble Cedex 9, France*
[3]*Félix Houphouët-Boigny University of Cocody, UFR SSMT, Laboratory of Atmospheric Physics and Fluid Mechanics (LAPA-MF), 22 BP 582 22 Abidjan, Ivory Coast*
[4]*National Center of Agronomic Research (CNRA), Central Laboratory of Biotechnology (LCB), 01 BP 1740 Abidjan 01, Ivory Coast*

45. Exploring institutional dimension of climate-smart agriculture in Nigeria

Fanen Terdoo[1], Olalekan Adekola[2]
[1]*Department of Geography and Environmental Science, University of Reading, United Kingdom*
[2]*Department of Geography, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria*

46. Critical reflection on knowledge and narratives of conservation agriculture in Zambia

Whitfield Stephen, Dougill, Andrew J., Dyer Jen C., Kalaba, Felix K., Leventon Julia, Stringer Lindsay C.
Sustainability Research Institute, University of Leeds, Leeds, LS2 9J, United Kingdom

47. Positive effect of climate change on cotton and rice in Africa and Madagascar

Gerardeaux Edward[1], Krishna Naudin[1], Ramanantsoanirina Alan[4], Dusserre Julie[1], Oetli Pascal[2], Oumarou Palai[3], Sultan Benjamin[2]
[1]*CIRAD, Avenue Agropolis - TA B-102 / 02 - 34398 Montpellier Cedex 5, France*
[2]*LOCEAN, IRD, Université Pierre et Marie Curie Boite 100, 4 Place Jussieu, 75252 Paris Cedex 5, France*
[3]*Sodecoton, 3Centre Régional de Recherche Agricole de Maroua, BP 33 Maroua, Cameroon*
[4]*Fofifa, Antsirabe, Madagascar*

48. Modeling potential impact of climate change on sorghum and cowpea yields in semi-arid areas of Kenya

Kitinya Kirina Thomas[1], Onwonga Richard N.[2], Kironchi Geoffrey[2], Mbuvi Joseph P.[2]
[1]*SNV Netherlands Development Organization-Cambodia, Premier Office Centre (POC), #184, Street 217 (Monireth), PO Box 2590, Phnom Penh, Cambodia*
[2]*Land Resource Management and Agricultural Technology (L.A.R.M.A.T), College of Agriculture and Veterinary Sciences, University of Nairobi, P.O. Box 29053-00625, Nairobi, Kenya*

49. Gender analysis of adaptation strategies of water stress among crop farmers in Asa local government area of Kwara State

Samuel O.F.[1], Aluko O.J.[1], Adejumo A.A.[2]
[1]*Department of Agricultural Extension and Management, Federal College of Forestry Ibadan, Forestry Research Institute of Nigeria, P.M.B 5087, Dugbe, Ibadan, Nigeria*
[2]*Department of Agricultural Extension and Rural Development, University of Ibadan, Nigeria*

50. Matching uses and functional traits of companion trees in cocoa agroforests: a win-win scheme toward resilient systems

Saj Stéphane[1,2], Jagoret Patrick[3]

[1]*UMR System, CIRAD, Direction Régionale, BP 2572, Yaoundé, Cameroon*

[2]*IRAD, Programme Plantes stimulantes, Direction Nkolbisson, Yaoundé, Cameroon*

[3]*UMR System, CIRAD, Bât 27, 2 place Viala, 34060 Montpellier Cedex 2, France*

51. Water requirements for potato production under climate change

Farag A.A.[1], Abdrabbo M.A.[1], Gad EL-Moula[1], Manal M.H.[1], McCarl B. A.[2]

[1]*Central laboratory for Agricultural Climate (CLAC), Agricultural Research Centre, Giza, Egypt*

[2]*Department of Agricultural Economics Texas A&M University, Texas, USA*

52. How smart is Climate Smart Agriculture (CSA)? – Lessons from Northern Nigeria

Adekola Olalekan[1], Terdoo Fanen[2]

[1]*Department of Geography, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria*

[2]*Department of Geography and Regional Planning, Federal University Dutsin-Ma, Katsina State, Nigeria*

53. Integrating climate smart agriculture for food security: the role of private sector investment in Africa

Kalimunjaye Samuel[1,2], Olobo Maurice[1], Kisenyi Vincent[1], Essegu J.F.[2], Okatono Isaac[1]

[1]*Uganda Christain University Mukono P.O.Box 4 Mukono Faculty of Business and Administration, Uganda*

[2]*National Agricultural Research Organisation/National Forestry Reseources Research Institute P.O.Box 1752 Kampala, Uganda*

54. Climate variability and Impacts on the population of leaf miner, a pest of the Oil Palm in Nigeria

Aneni Thomas, Aisagbonhi Charles

Nigerian Institute for Oil Palm Research (NIFOR), Entomology Division, 30001, Benin-City, Nigeria

L1.2 AUSTRALASIA

55. The agro-potential of Western Siberia territories in a changing climate

Nikitich Polina[1,2,3], Bredoire Felix[4,5], Alvarez Gaël[6], Barsukov Pavel[7], Bakker Mark[8], Buée Marc[9], Derrien Delphine[1], Fontaine Sebastien[6], Kayler Zachary[10], Rusalimova Olga[7], Vaishlya Olga[2], Zeller Bernd[1]

[1]*INRA Nancy-Lorraine - Biogeochemistry of Forest Ecosystems, Champenoux, France*

[2]*Tomsk State University, Tomsk, Russia*

[3]*Université de Lorraine, Vandoeuvre les Nancy, France*

[4]*INRA Bordeaux-Aquitaine - UMR 1391 ISPA, Villenave d'Ornon, France*

[5]*Université de Bordeaux, Bordeaux, France*

[6]*INRA Clermont - UREP, Clermont Ferrand, France*

[7]*Institute of Soil Sciences and Agrochemistry, Novosibirsk, Russia*

[8]*Bordeaux Sciences Agro, UMR 1391 ISPA, Gradignan, France*

[9]*INRA Nancy-Lorraine - Interactions Arbres-Microorganismes, Champenoux, France*

[10]*Institute for Landscape Biogeochemistry - ZALF, Müncheberg, Germany*

56. Ecological intensification through conservation agriculture in Cambodia: impact on SOC, N and enzymatic activities

Tivet Florent[1,2], Hok Lyda[3,4], Boulakia Stéphane[1], de Moraes Sá João Carlos[5], Kong Rada[2], Leng Vira[2], Briedis Clever[5]

[1]*Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), UR AIDA/CSIA, Avenue Agropolis, 34398 Montpellier, France*

[2]Ministry of Agriculture, Forestry and Fisheries, General Directorate of Agriculture, Conservation Agriculture Service Centre, Phnom Penh, Cambodia
[3]Department of Soil Science, Faculty of Agronomy, Royal University of Agriculture, P.O. Box 2696, Phnom Penh, Cambodia
[4]Department of Natural Resources and Environmental Design, North Carolina A&T State University, Greensboro, NC 27411, USA
[5]Department of Soil Science and Agricultural Engineering, State University of Ponta Grossa, Av. Carlos Cavalcanti 4748, Campus de Uvaranas, 84030-900, Ponta Grossa, PR, Brazil

57. Net ecosystem exchange of carbon dioxide and methane in rice fields of northern Indo-Gangetic Plains

Bhatia A.[1], Kumar A.[1], Jain N.[1], Mishra S.V.[1], Sehgal V. K.[2], Pathak H.[1]
[1]Centre for Environment Science and Climate Resilient Agriculture (CESCRA), IARI, New Delhi-110012, India
[2]Division of Agricultural Physics, IARI, New Delhi-110012, India

58. Are tree plantations climate-smart? The case of rubber tree plantations and the natural rubber commodity chain

Gay F.[1], Angthong S.[2], Bessou C.[3], Bottier C.[4], Brauman A.[5], Chambon B.[3], Chantuma P.[6], Gohet E.[3], Lacote R.[3], Liengprayoon S.[7], Poonpipope K.[8], Thaler P.[1], Thanisawanyangkura S.[9], Vaysse L.[4], Winsunthorn S.[10], Sainte-Beuve J.[4]
[1]CIRAD, UMR Eco&Sols, 34060, Montpellier, France
[2]ORRAF, 10700, Bangkok, Thaïland
[3]CIRAD, UPR Performances des systèmes de pérenne, 34398, Montpellier, France
[4]CIRAD, UMR IATE, 34060, Montpellier, France
[5]IRD, UMR Eco&Sols, Montpellier, France
[6]DOA, RRIT, 10900, Bangkok, Thailand
[7]Kasetsart University, Faculty of Agro-Industry, 10900, Bangkok, Thailand
[8]Kasetsart University, Faculty of Agriculture, 10900, Bangkok, Thailand
[9]Kasetsart University, Faculty of Science, 10900, Bangkok, Thailand
[10]PSU, Faculty of Science and Industrial Technology, 84000, Surat Thani, Thailand

59. Potential integrated agricultural technologies for climate-smart villages of Southeast Asia

Campilan Dindo
International Center for Tropical Agriculture - Asia Region, c/o Agricultural Genetics Institute, Pham Van Dong, Tu Liem District, Hanoi, Vietnam

60. Enhancing productivity and livelihoods among smallholder irrigators through Biochar and fertilizer amendments

Macedo, Jenkins[1], Souvanhnachit, M.[2], Rattanavong, S.[3], Maokhamphiou, B.[4], Sotoukee, T.[4], Pavelic, P.[4], Sarkis, M.[1], Downs, T.[1]
[1]Department of International Development, Community, and Environment, Clark University, Worcester, MA. USA
[2]Department of Water Resources Engineering, National University of Laos, Vientiane, Lao PDR
[3]Independent Consultant, Washington DC, USA
[4]International Water Management Institute Vientiane, Lao PDR

61. Climate change and agriculture in India

Jha Anil Kumar
Govt. Girls P.G. College, Morar, (Jiwaji University), Gwalior, Madhya Pradesh, India

62. A suitability assessment for "alternate wetting and drying": targeting priority areas for mitigation in rice production

Sander Bjoern Ole[1], Wassmann Reiner[1], Nelson Andrew[1], Palao Leo[1], Wollenberg Eva[2]
[1]*International Rice Research Institute (IRRI), Los Baños, Philippines*
[2]*University of Vermont, Burlington, Vermont, USA*

L1.3 LATIN AMERICA

63. Learning to face the challenges posed by climate change to Andean agriculture: teaching the farmers of the future

Quiroz Roberto, Valdivia Roberto, Turin Cecilia, León-Velarde Carlos, Mares Victor
International Potato Center (CIP), Lima 12, Lima, Peru

64. Comparison between a Tier 3 and Tier 2 approach to estimate enteric methane emission in Brazilian beef cattle

Bannink André[1], Geraldo de Lima Jacqueline[2], Van Den Pol-Van Dasselaar Agnes[1], Menezes Santos Patricia[3], Resende Siqueira Gustavo[4], Barioni Luis[5]
[1]*Wageningen UR Livestock Research, PO Box, 65, 8200 A Lelystad, Netherlands*
[2]*University of São Paulo, Avenida Pádua Dias, 11, 13418-900, Piracicaba, Brazil*
[3]*Embrapa Southeast Livestock, Rodovia Washington Luiz, km 234, 13560-970 São Carlos, Brazil*
[4]*São Paulo Agency of Agribusiness Technology, Rui Barbosa avenue, 35, 14.770-000, Colina, São Paulo, Brazil*
[5]*Embrapa Informática Agropecuária, Avenida André Tosello, n209, Barão Geraldo, 60411-308, Campinas, Brazil*

65. Effect of climate variability and climate change in the agricultural sector of Panama.

Martiz Graciela
Ministry of Agricultural Development, Environmental Unit, Panama

66. Adaptation of small coffee producers to climate change in Nicaragua

Sepúlveda Norvin
CATIE, Km 8 carretera a Masaya (MAGFOR), codigo 10000, Managua, Nicaragua

67. Can CO_2 fertilization compensate for progressive climate change impacts on coffee productivity?

Ovalle-Rivera Oriana[1], Van Oijen, Marcel[2], Läderach Peter[3], Roupsard Olivier[4], Rapidel Bruno[5]
[1]*CATIE, Division de Posgrado, 7170, Turrialba, Costa Rica*
[2]*CEH, Edinburgh, United Kingdom*
[3]*CIAT, Managua, Nicaragua*
[4]*CIRAD, UMR Eco&Sols, Montpellier, France, and CATIE, DID-PAAS, Turrialba, Costa Rica*
[5]*CIRAD, UMR SYSTEM; Montpellier, France, and CATIE, DID-PAAS, Turrialba, Costa Rica*

68. Agricultural practices, agroecological integrated farms and sustainable indigenous territorial development in Honduras

Juan Medina[1], Edwin Torres[2]
[1]*CATIE, The Tropical Agricultural Research and Higher Education Center, Tegucigalpa, Honduras*
[2]*FUNACH, Action Aid Foundation Honduras. Victoria, Yoro, Honduras*

69. Methane emission efficiency as a function of grazing management in Southern Brazilian grazing systems

Savian Jean V.[1], Cezimbra Ian M.[1], Filho William S.[1], Bonnet Olivier J.F.[1], Neto Armindo B.[14], Schons Radael M.T.[1], Tischler Marcelo R.[1], Nunes Pedro A.A.[1], Almeida Gleice M.[1], Araújo Bárbara[1], Barro Raquel[1], Genro Teresa C.M.[2], Berndt Alexandre[2], Barioni Luis G.[2], Bayer Cimelio[1], Carvalho Paulo C.F.[1]

[1]*Grazing Ecology Research Group, Faculty of Agronomy, Federal University of Rio Grande do Sul, 91501-970, Porto Alegre, Brazil*

[2]*Brazilian Agricultural Research Corporation (EMBRAPA), Brazil*

70. Technological options to increase resilience of production systems to extreme climate events

Bolaños Benavides Martha Marina., Ospina P. Carlos Eduardo, Rodríguez B. Gonzalo Alfredo, Martínez M. Juan Carlos, Galindo P. Julio Ricardo, Ayarza Miguel.

Corporación Colombiana de Investigación Agropecuaria CORPOICA, Colombia

71. Supporting dairy family farmers of Pernambuco state (Brazil) to develop a climate-smart agriculture

Fages Marjolaine[1], Le Guen Roger[1], Côrtes Cristiano[2], Silva de Melo Airon Aparecido[3]

[1]*Groupe ESA, Laboratoire LARESS, 49 007, Angers, France*

[2]*Groupe ESA, Laboratoire URSE, 49 007, Angers, France*

[3]*Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Garanhuns, CEP 55292-270, Garanhuns/PE, Brazil*

72. Energy efficiency of beef cow herds with different calving season in the south-east of Buenos Aires province, Argentina

Ricci Patricia[1], Aello, Mario S.[2], Arroquy José Ignacio[3], Rearte Daniel[4]

[1]*Instituto Nacional de Tecnología Agropecuaria (INTA), Animal Nutrition Group, 7620, Balcarce, Argentina*

[2]*Universidad Nacional de Mar del Plata, Facultad de Ciencias Agrarias, Animal Nutrition Group, 7620, Balcarce, Argentina*

[3]*CITSE- CONICET, FAyA-UNSE, and INTA, 4200, Animal Production Group, Santiago del Estero, Argentina*

[4]*Labintex, Agropolis International, F-34394, Montpelier, France*

73. Does diversification in smallholder coffee landscapes help to face climate change risk? Answers from Nicaragua

van Zonneveld, Maarten[1], Gonzalez Daysi[2], Guevara Ramon[3], Fallot Abigail[4]

[1]*Bioversity International, CATIE 7170 Turrialba, Costa Rica*

[2]*Research Platform on Production and Conservation in Partnership (RP-PCP), CATIE 7170, Turrialba, Costa Rica*

[3]*Independent consultant, Managua, Nicaragua*

[4]*Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), CATIE 7170 Turrialba, Costa Rica*

74. Ensuring climate smart agriculture is gender-smart: lessons from Latin America

Twyman Jennifer[1], Bernier Quinn[2], Muriel Juliana[1], Paz Liliana[3], Ortega Luis[3]

[1]*Centro Internacional de Agricultura Tropical (CIAT), KM 17 Recta Cali-Palmira, Cali, Colombia*

[2]*International Food Policy Research Institute, 2033 K St, NW, Washington, DC 20006-1002, USA*

[3]*EcoHabitats, Popayan, Colombia*

75. Do local perceptions converge to climatological data? Case studies in three Brazilian biomes

Litre Gabriela[1], Nasuti Stephanie[1], Lindoso Diego[1], Saito Carlos[1], Henke Carlos[1], Da Silva Carolina Joana[2], Eiro Flavio[3]

[1]*Centro de Desenvolvimento Sustentável - CDS, Campus Universitário Darcy Ribeiro - Gleba A - Asa Norte – Brasília-DF, CEP 70.904-970, Brazil*

[2]Universidade do Estado de Mato Grosso, Av. Tancredo Neves, 1095 - Cavalhada II, 78200-000 - Cáceres - Mato Grosso, Brazil
[3]ERIS-CMH, 48 bd Jourdan, 75014 Paris, France

76. Does carbon storage of pastures contribute to a climate smart cattle farming after Amazonian deforestation?

Blanfort Vincent[1], Stahl Clément[1,2], Fontaine Sébastien[3], Picon-Cochard Catherine[3], Freycon Vincent[4], Blanc Lilian[4], Bonal Damien5, Soussana Jean-François[3], Lecomte Philippe[1], Klumpp Katja[3]
[1]CIRAD, UMR 112 Tropical and Mediterranean Animal Production Systems, Campus international de Baillarguet, 34398 Montpellier, France
[2]INRA, UMR 0745 Ecofog, Campus agronomique, 97379 Kourou, France
[3]INRA, UR 874, Grassland Ecosystem Research Team, 63100 Clermont-Ferrand, France
[4]CIRAD, UR 105 "Biens et services des écosystèmes forestiers tropicaux", 34398 Montpellier, France
[5]INRA, UMR 1137 EEF, 54280 Champenoux, France

77. Socio-economic scenarios to develop and test agricultural adaptation policies in Central America and the Andes

Veeger Marieke, Vervoort Joost
University of International Cooperation (UCI), De la Rotonda El Farolito, 200m este y 150m norte, Barrio Escalante, San José, Costa Rica

78. Future climate change impacts on maize production in the Cerrado of Brazil

Silva Fernando Macena[1], Affholder François[2], Corbeels Marc[1,2]
[1]Embrapa-Cerrados, 73310-970, Planaltina, DF, Brazil
[2]CIRAD, Agroécologie et intensification durable des cultures annuelles, 34398 Montpellier, France

79. Agro-Climatic forecasting system for better decision making in Latin America

Giraldo Diana, Barrios Camilo, Arango David, Obando Diego
International Center for Tropical Agriculture (CIAT), Climate and crop modeling team in DAPA. Km 17, Recta Cali-Palmira, Valle Del Cauca, Colombia

80. LivestockPlus: supporting low emission development for livestock sector in Costa Rica and Colombia

Rao Idupulapati[1], Jenet Andreas[2], Tapasco Jeimar[1], Chirinda Ngonidzashe[1], Rosenstock Todd[3], Twyman Jennifer[1], Laderach Peter[1], Peters Michael[1], Arango Jacobo[1], Hyman Glenn[1], Barahona Rolando[4], Nelson Vivas[5], Camilo Plazas[6], Mauricio Chacon[7]
[1]CIAT, Cali, Colombia
[2]CATIE, Turrialba, Costa Rica
[3]ICRAF, Nairobi, Kenya
[4]National University, Medellin, Colombia
[5]University of Cauca, Popayan, Colombia
[6]University of Llanos, Villavicencio, Colombia
[7]Ministry of Agriculture and Livestock, San José, Costa Rica

81. Venezuelan agriculture N management challenges and proposed alternatives

Pérez Tibisay, Marquina Sorena
Centro de Ciencias Atmosféricas y Biogeoquímica. IVIC. Apartado. 20632, Caracas 1020A, Venezuela

82. Nitrous oxide emission factors for sheep and cattle excreta in two subtropical Brazilian grazing systems

Bastos Diego F.[1], Schirmann Janquieli[1], Magiero Emanuelle C.[1], Carvalho Paulo C.F.[2], Bayer Cimelio[1]

[1] Department of Soil Science and Graduate Program on Soil Science, Faculty of Agronomy, Federal University of Rio Grande do Sul, 91540-000, Porto Alegre, RS, Brazil
[2] Grazing Ecology Research Group, Faculty of Agronomy, Federal University of Rio Grande do Sul, 91501-970, Porto Alegre, Brazil

83. Sustainability of rice cultivation in an important producing area of Cuba under climatic scenarios

Rodriguez Baide Joysee M.[1], van den Berg Maurits[1], Soto Carreño Francisco[2], Maqueira Lopez. Lazaro A.[3], Vázquez Montenegro Ranses J.[4]
[1]*European Commission. Joint Research Centre, Institute for Environment and Sustainability, Monitoring Agricultural ResourceS Unit, Ispra, Italy*
[2]*Instituto Nacional de Ciencias Agrícolas, Mayabeque, Cuba*
[3]*Instituto Nacional de Ciencias Agrícolas, Los Palacios, Cuba*
[4]*Centro de Meteorología Agrícola, Instituto de Meteorología, La Habana, Cuba*

L1.4 EUROPE

84. Innovation for Climate Smart Agriculture in Europe

Touzard Jean-Marc
INRA, UMR 0951 "Innovation", 2 place Viala, F-34060 Montpellier Cedex 01, France

85. Nitrogen and water as inputs in farm bio-economic models: creating an operational modeling framework at the EU level

Humblot Pierre, Petsakos Thanasis, Jayet Pierre-Alain
INRA, UMR Economie Publique, Avenue Lucien Bretignières, F-78850 Thiverval Grignon, France

86. « PigChange »: a project to evaluate the consequences of climate change and mitigation options in pig production

Renaudeau David[1], Gourdine Jean Luc[2], Hassouna Melynda[3], Robin Paul[3], Gilbert Hélène[4], Riquet Juliette[4], Dourmad Jean Yves[1]
[1]*INRA, UMR 1348 PEGASE, F35590 St-Gille, France*
[2]*INRA, UR 143 URZ, F97170 Petit Bourg, France*
[3]*INRA, UMR 1069 SAS, F35000 Rennes, France*
[4]*INRA, UMR 1388 GenPhySE, F31326 Toulouse, France*

87. Assessing the economic GHG abatement potential from the EU-15 dairy sector and underlying uncertainties

Koslowski Frank[1], Eory Vera[1], van den Pol-van Dasselaar Agnes[2], Fofana Abdulai[1], de Haan Michel[2], Lesschen Jan Peter[3], Moran Dominic[1]
[1]*Land Economy, Environment & Society Research Group, Scotland's Rural College, Edinburgh EH9 3JG, Scotland, United Kingdom*
[2]*Wageningen UR Livestock Research, Postbus 338, 6700 AH Wageningen, the Netherlands*
[3]*Alterra, Wageningen UR, P.O. Box 47, 6700AA Wageningen, the Netherlands*

88. Concerted action for climate smart livestock systems: research & innovation priorities in climate changing Europe

Scholte Martin C.Th.[1,2,3]
[1]*Board of Directors Wageningen UR*
[2]*President Animal Task Force*
[3]*Co-chair GRA Livestock Research Group*

89. An observatory of aromatic and medicinal plants as a possible indicator of the climatic changing evolution conditions

Hoxha Valter[1], Ilbert Hélène[2]
[1]UMR TETIS (Mixed Unit of Territories Research, Environment, Remote Sensing and Spatial Information) - House of Remote Sensing - 500 rue Jean-François Breton 34093 Montpellier Cedex 5, France
[2]UMR1110 MOISA (Markets, Organizations, Institutions and Operators Strategies). Campus Montpellier SupAgro / INRA 2 place Pierre Viala 34060 Montpellier Cedex 2, France

90. The knowledge hub FACCE MACSUR: Modelling agriculture with climate change for food security

Köchy Martin, Banse Martin
Thünen Institute for Market Analysis, Bundesallee 50, 38116 Braunschweig, Germany

91. Can functional complementarity of plant strategies enhance drought resilience in associations of Mediterranean grasses?

Barkaoui Karim[1], Bristiel Pauline[2], Birouste Marine[2], Roumet Catherine[2], Volaire Florence[3]
[1]CIRAD, UMR SYSTEM, 2 place Pierre Viala, 34060, Montpellier Cedex 2, France
[2]CEFE UMR 5175, Université de Montpellier – Université Paul Valéry –19 EPHE, 1919 route de Mende, 34293 Montpellier Cedex 5, France
[3]INRA, USC 1338, CEFE UMR 5175, Université de Montpellier – Université Paul Valéry –19 EPHE, 1919 route de Mende, 34293 Montpellier Cedex 5, France

92. Incremental adaptation in crop management for integrated assessments of climate change impacts in Europe

Webber Heidi[1], Britz Wolfgang[2], Zhou G.[1], de Vries Wim[3], Wolf Joost[4], Ewert Frank[1]
[1]INRES, University of Bonn, Bonn, Germany
[2]ILRI, University of Bonn, Bonn, Germany
[3]Alterra, Wageningen University, Wageningen, the Netherlands
[4]Plant Production Systems, Wageningen University, Wageningen, the Netherlands

93. Sensitivity of maize to climate change in Denmark: an analysis using impact response surface approach

Ozturk Isik, Sillebak K. Ib, Olesen E. Jørgen
Department of Agroecology, Aarhus University, Blichers Alle 20 DK-8830, Tjele, Denmark

94. Is it possible to reduce greenhouse gas emissions without reducing production? An assessment of 26 technical options

Pellerin Sylvain[1], Bamière Laure[2], Angers Denis[3], Béline Fabrice[4], Benoît Marc[5], Butault Jean-Pierre[6], Chenu Claire[7], Colnenne-David Caroline[8], De Cara Stéphane[2], Delame Nathalie[2], Doreau Michel[5], Dupraz Pierre[9], Faverdin Philippe[10], Garcia-Launay Florence[10], Hassouna Melynda[11], Hénault Catherine[12], Jeuffroy Marie-Hélène[8], Klumpp Katja[13], Metay Aurélie[14], Moran Dominic[15], Recous Sylvie[16], Samson Elisabeth[11], Savini Isabelle[17], Pardon Lénaic[17]
[1]INRA, UMR ISPA, 33882 Villenave d'Ornon, France
[2]INRA, UMR Eco-Pub, 78850 Thiverval-Grignon, France
[3]Agriculture et Agroalimentaire Canada, Québec (Québec), G1V2J3, Canada
[4]IRSTEA, UR GERE, 35044 Rennes, France
[5]INRA, UMR Herbivores, 63122 Saint-Genes-Champanelle, France
[6]INRA, UMR LEF, 54042 Nancy, France
[7]AGROPARISTECH, UMR IEES, 75005 Paris, France
[8]INRA, UMR Agronomie, 78850 Thiverval-Grignon, France
[9]INRA, UMR SMART, 35011 Rennes, France
[10]INRA, UMR PEGASE, 35590 Saint Gilles, France

[11]INRA, UMR SAS, 35042 Rennes, France
[12]INRA, UR USS, 45075 Orléans, France
[13]INRA, UR Ecosytème Prairial, 63039 Clermont-Ferrand, France
[14]SUPAGRO, UMR SYSTEM, 34060 Montpellier, France
[15]SRUC, Land Economy and Environment Research, EH9 3JG, Edinburgh, United Kingdom
[16]INRA, UMR FARE, 51686 Reims, France
[17]INRA, DEPE, 75338 Paris, France

95. Agroforestry for a climate-smart agriculture – a case study in France

Cardinael Rémi[1,4], Chevallier Tiphaine[1], Germon Amandine[3], Jourdan Christophe[2], Dupraz Christian[3], Barthès Bernard[1], Bernoux Martial[1], Chenu Claire[4]
[1]IRD, Umr Eco&Sols, 34060 Montpellier, France
[2]CIRAD, Umr Eco&Sols, 34060 Montpellier, France
[3]INRA, Umr System, 34060 Montpellier, France
[4]AgroParisTech, IEES, 78850 Thiverval-Grignon, France

96. Impacts of climate and socio-economic change at farm and landscape level in the Netherlands: climate smart agriculture?

Reidsma Pytrik[1], Bakker Martha M.[2], Kanellopoulos Argyris[1,3], Alam Shah J. [4], Paas Wim[1,5], Kros Johannes[6], de Vries Wim[6,7]
[1]Plant Production Systems Group, Wageningen University, P.O. Box 430, 6700 AK Wageningen, the Netherlands
[2]Land Use Planning Group, Wageningen University. P.O. box 47, 6700 AA Wageningen, the Netherlands
[3]Operational Research and Logistics Group, Wageningen University, Hollandseweg 1, 6706 KN Wageningen, the Netherlands
[4]School of GeoSciences, University of Edinburgh, Drummond Street, Edinburgh EH8 9XP, United Kingdom
[5]Farming Systems Ecology Group, Wageningen University, P.O. Box 430, 6700 AK Wageningen, the Netherlands
[6]Alterra Wageningen UR, P.O. box 47, 6700 AA Wageningen, the Netherlands
[7]Environmental Systems Analysis Group, Wageningen University, P.O. Box 47, 6700 AA Wageningen, the Netherlands

97. Sustainability of agriculture: can climate change adaptations attract youth into agriculture?

Betigül Onay Özman
YADA Foundation (Yaşama Dair Vakıf), Turkey

L1.5 NORTH AMERICA

98. A research program to address agricultural stakeholders' concerns regarding the evolution of crop pests associated with climate change

Blondlot Anne[1], Gagnon Annie-Ève[2], Bourgeois Gaétan[3], Brodeur Jacques[4], Mimee Benjamin[3] and colleagues
[1]Ouranos, Montreal, Quebec, Canada
[2]Centre de recherche sur les grains (CÉROM), Saint-Mathieu-de-Beloeil, Quebec, Canada
[3]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, Quebec, Canada
[4]Institut de recherche en biologie végétale, Université de Montréal, Montreal, Quebec, Canada

99. Bioenergy crop impacts on soil carbon sequestration, soil biophysical properties and N_2O emissions in Manhattan, Kansas

McGowan Andrew[1], Yishak Elias[2], Rice Charles[1]

[1]Department of Agronomy: Kansas State University, 66506, Manhattan, United States
[2]Department of Mechanical Engineering: University of Maryland, 20742, College Park, United States

100. Understanding farm level N_2O emissions in California systems

Decock Charlotte[1], Verhoeven Elizabeth[1], Pereira Engil[1], Garland Gina[1], Kennedy Taryn[2], Suddick Emma[3], Burger Martin[4], Horwath Willam[4], Six Johan[1]
[1]ETH Zurich, Department of Environmental Systems Science, 8092 Zurich, Switzerland
[2]University of California Davis, Department of Plant Sciences, 95616 Davis, California, USA
[3]Woods Hole Research Center, 02540-1644 Falmouth, Massachusetts, USA
[4]University of California Davis, Department of Land, Air and Water Resources, 95616 Davis, California, USA

101. A transdisciplinary approach for climate smart management of maize

Wright Morton Lois, Arritt Raymond, the CSCAP Team
Iowa State University, Ames, Iowa 50011, USA

ORAL PRESENTATIONS

Parallel session L1.1
Africa

Monday, 16 March 2015

14:00–18:00

ROOM SULLY 1

KEYNOTE PRESENTATIONS

14:00 Engendering climate resilient agricultural livelihoods in Africa

Opondo Maggie[1], Nyasimi Mary[2]

[1]*Institute for Climate Change & Adaptation, University of Nairobi, Kenya*
[2]*International Livestock Research Institute, Nairobi, Kenya*

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (2014), finds that climate change will interact with non-climatic drivers and stressors to exacerbate vulnerability of African agricultural systems, particularly in the semi-arid areas. This is because increasing temperatures and changes in precipitation are very likely to reduce cereal crop productivity, thus adversely affecting food security. At the same time rising temperatures could also negatively affect high-value perennial crops. Thus leading to an erosion of climate sensitive agricultural livelihoods such as rain-fed smallholder agriculture, seasonal employment in agriculture (*e.g.*, tea, coffee, sugar), fishing and pastoralism Agricultural livelihoods often interact with climate change, climate variability and extreme events in multi-faceted and complex ways. Gender in conjunction with other factors such as age, wealth, poverty and class determines the ways in which climate change is experienced. Weather events and climate related disasters acting together with other socio-economic, institutional, cultural and political drivers tend to intensify the existing gender inequalities.

Gender dimensions of vulnerability often result from differential access to social and environmental resources needed for adaptation. In many agricultural economies, women usually have poorer access than men to financial resources, land, education, health and other basic rights. Less than 20% of the world's landholders are women and yet women play a disproportionate role in agriculture – in Africa more than 60% of employed women work in agriculture. Further, because women tend to be excluded from decision-making processes and labour markets, they are less able to cope with and adapt to the impacts of climate change.

While, women's differential vulnerability to extreme events has long been documented, there is now increasing evidence that masculine roles can affect men's vulnerability. The literature on the gendered implications of climate change in agricultural economies underscores how gendered division of labour and responsibilities can create differentiated and distinct vulnerabilities at varying scales (household, community and country). The implications of these findings underscore the importance of integrating a gender analysis in the design of any response that seeks to tackle climate variability and change related vulnerabilities among agricultural communities.

However, most of the studies and climate change interventions that advocate for the incorporation of a gender analysis are based on a fairly narrow construction of gender as binary (men versus women). And yet gender as a social categorization gains meaning from its intersection with other identities, roles and responsibilities. Many of the constraints and opportunities confronting agricultural communities in the face of a changing and variable climate are influenced by other factors such as age, wealth, poverty, ethnicity, race and class. By using a binary gendered lens some of the needs of the most vulnerable and marginalised communities could be overlooked by climate smart agricultural interventions meant to reduce their vulnerabilities. A gendered binary analysis does not capture the most pertinent and significant social factors influencing agricultural decision-making and vulnerability to climate change.

It is critical to frame gender as a social construction that becomes significant only through its time- and place-specific interaction with other socially relevant categories. Thus it is important to understand the locally specific identities and activities that intersect to produce varying vulnerabilities among agricultural communities and households.

A gender-sensitive response requires more than a set of disaggregated data showing that climate change has differential impacts on women and men. It requires an understanding of existing inequalities between women and men, and of the ways in which climate change can exacerbate these inequalities. It also requires an understanding of the ways in which these inequalities can intensify the impacts of climate change for all individuals and communities. Recognizing gender differences in vulnerability and adaptation can enable gender-sensitive responses that reduce vulnerability of men and women. Thus interventions that are not sensitive to gender dimensions and other drivers of social inequalities risk reinforcing existing vulnerabilities.

14:30 Integrating ecosystem-based adaptation and mitigation in Africa: policy and practice

Locatelli Bruno

CIRAD-CIFOR, Montpellier 34098, France

Ecosystem conservation and management have been highlighted as important interventions for climate change mitigation because of the potential of ecosystems to store carbon storage. Ecosystems can also play other frequently overlooked, but significant, roles in helping society adapt to climate variability and change by providing important ecosystem services. Recognizing this role of ecosystems, several international and nongovernmental organizations have promoted an ecosystem-based approach to adaptation or EbA (Ecosystem-based Adaptation) and several projects and policies in Africa are integrating EbA. This approach to adaptation is an integral part of climate-smart landscapes, which are managed for three objectives: mitigating climate change, contributing to societal adaptation and ensuring that the direct and indirect impacts of climate change on landscapes and their ecosystems are minimized.

The scientific literature on ecosystem services and societal vulnerability to climate variations shows the diversity of situations in which EbA can be observed in Africa. The presentation will describe six cases in which ecosystem can support adaptation and will provide examples in Africa: (1) ecosystems providing goods to local communities facing climatic threats; (2) trees in agricultural fields and pasture regulating water, soil, and microclimate for more resilient crop or livestock production; (3) ecosystems regulating water and protecting soils for reduced climate impacts in watersheds; (4) mangroves and coastal ecosystems protecting coastal areas from climate-related threats; (5) urban forests and trees regulating temperature and water for resilient cities; and (6) ecosystems regulating regional climate for example through rainfall recycling.

The literature provides evidence that EBA can reduce social vulnerability to climate hazards; however, uncertainties and knowledge gaps remain, particularly for regulating services at large scale (watersheds, coastal areas and region). A limited number of studies are available on EBA specifically, but the abundant literature on ecosystem services can be used to fill knowledge gaps. Many studies assess the multiple benefits of ecosystems for human adaptation or well-being, but also recognize trade-offs between ecosystem services. Better understanding is needed of the efficiency, costs, and benefits, and trade-offs of EBA with forests and trees. Pilot projects under implementation could serve as learning sites and existing information could be systematized and revisited with a climate change lens.

The management of ecosystems for responding to climate change challenges should take place at the landscape level. A spatially explicit approach is needed to understand how ecosystems influence societal adaptation, for example through the water regulation services provided by upstream ecosystems to downstream populations. Such an approach is also needed to analyze how ecosystems may be affected by - and adapt to - climate change; for example because connectivity between forested areas influences how plants and species can migrate as a result of climate change. In addition to considering spatial dimensions in analyzing problems or solutions, the landscape approach provides a framework for action, in which stakeholders and institutions work together in implementing climate-smart landscape management and negotiating trade-offs.

CONTRIBUTED ORAL PRESENTATIONS

16:30 Climate smart practices impact soil organic carbon storage in Madagascar

Razafimbelo Tantely[1], Razakamanarivo Herintsitohaina[1], Rafolisy Tovonarivo[1], Rakotovao Narindra[1], Saneho Tiana[1], Andriamananjara Andry[1], Fanjaniaina Marie Lucia[1], Rakotosamimanana Stéphan[2], Deffontaines Sylvain[2], Virginie Falinirina[1], Laetitia Bernard[3], Dominique Masse[3], Albrecht Alain[3]

[1]*Laboratoire des Radioisotopes, Université d'Antananarivo, BP 3383, Antananarivo, Madagascar*

[2]*Agrisud International, Lot VL32M Androndra, 101 Antananarivo, Madagascar*

[3]*Institut de Recherche pour le Développement, UMR Eco&Sols, 34060 Montpellier, France*

Climate smart agriculture is presented recently as a solution for food security and climate change impacts. In Madagascar, different sustainable agricultural practices were implemented for 20 years now by many NGOs in order to increase crop yield, to maintain soil fertility and to increase household income. These practices are conservation agriculture (CA), agroforestry, forestry, rice practices as alternating wetting and drying irrigation (AWR), and the use of organic manure. While the effects of these practices on crop yield are extensively studied, it is less the case of their ability to mitigate greenhouse gas emission (GHG). This study aimed to compare the soil organic carbon (SOC) storage of some climate smart practices cited above in the Malagasy context. SOC stocks of each practice, distributed in several sites throughout the island, were measured and compared with the traditional practices of each site respectively. For the conservation agriculture, the difference of SOC storage yield, compared to traditional practices (tillage and crop residues exported), varied from 0 to 1.816 Mg C.ha^{-1} year^{-1}. Soils from Agroforestry systems, stored 0.668 MgC.ha^{-1}.year^{-1} more than slash-and-burn practices in the East Coast of Madagascar but no significant SOC storage were found for Agroforestry systems of the Malagasy Highlands. However, the use of AWR in lowland rice induced a SOC storage of 0.6 MgC.ha^{-1}.year^{-1} comparable with the traditional irrigated rice (SRA), and finally the use of organic fertilizers as urban organic waste, compost and manure led to an increase of SOC of 0.609, 0.752 and 0.158 MgC.ha^{-1}.year^{-1}, respectively. Therefore, results confirmed the capacity of these studied climate smart practices to store carbon in soil and then to mitigate GHG emission. However, their potentialities to mitigate GHG are quite different according to the practices and their spatial extent.

16:45 A modelling framework to assess climate change and adaptation impact on heterogeneous crop-livestock farming communities

Descheemaeker Katrien[1], Masikati Patricia[2], Homann-Kee Tui Sabine[3], Chibwana Gama Arthur[4], Crespo Olivier[5], Claessens Lieven[6], Walker Sue[7]

[1]*Plant Production Systems, Wageningen University, PO Box 430, 6700 AK Wageningen, The Netherlands*

[2]*World Agroforestry Centre (ICRAF), Lusaka, Zambia*

[3]*International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), P O Box 776, Matopos, Bulawayo, Zimbabwe*

[4]*Lilongwe University of Agriculture and Natural Resources, P.O. Box 21,9 Lilongwe, Malawi*

[5]*Climate System Analysis Group, Environmental and Geographical Science Dept., University of Cape Town, Rondebosch, South Africa*

[6]*International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), P.O. Box 39063, 00623 Nairobi, Kenya*

[7]*Crops For the Future Research Centre, Semenyih, Selangor Darul Ehsan, Malaysia*

Climate change will impact the productivity of maize-based crop-livestock systems and the livelihoods of smallholders depending on them in semi-arid Zimbabwe. The large diversity in resource endowment and production objectives in rural communities differentially influences this impact and the adaptation potential of households. Also, crops and livestock are affected differently by climate change. Information on the effects on whole-farm productivity, income and food self-sufficiency is scarce and knowledge on the disaggregated benefits of climate-smart interventions for heterogeneous farmer populations is needed to better target decision support. Linking climate with dynamic crop and livestock models, and an economic model, an integrated multi-model framework was developed for analyzing the sensitivity of current systems to climate change and the potential for future systems to adapt. Information on assets and farm management from 160 households in Nkayi district allowed categories of low, medium and high resource endowment to be distinguished. Results of 20 GCMs indicated that by mid-century Nkayi will become warmer with a reduction in early-season rainfall. The APSIM and DSSAT crop models predicted a 1-9% and >15% decline in actual and potential maize yield respectively. Using crop model results as input, the LivSim livestock model indicated small impacts on milk and animal production that varied strongly across farms. Integrating crop and livestock model outputs in the whole-farm economic model TOA-MD, we predicted that 60% of Nkayi farmers will be adversely impacted by climate change. Fertilizer and leguminous forages can mitigate climate change effects on crop and livestock production and reduce the proportion of vulnerable households to 20%. Benefits differ by farm type: with small benefits (200-500 US$) from adaptation options, small and medium farms remain poor, while better-off farms increase income more substantially (by 1200 US$). Our integrated modelling framework allows ex-ante impact assessment of incremental but also more transformative climate-smart interventions on heterogeneous farming communities vulnerable to climate change.

17:00 Closing yield gaps to increase food supply and mitigate GHG emissions for African smallholders

Henderson Ben[1], van Wijk Mark[2], Rigolot Cyrille[1], Silvestri Silvia[2], Douxchamps Sabine[2], Herrero Mario[1]

[1]*CSIRO, 306 Carmody Rd, St Lucia, 4067, Australia*

[2]*ILRI, Nairobi 00100, Kenya*

For developing country agriculture to contribute to climate change mitigation, a credible pathway for achieving both development and environmental goals is needed. To deliver these dual objectives, strategies based on improving farm productivity and closing yield gaps are receiving increasing attention. In this study we estimate yield gaps for smallholder farmers in six Sub-Saharan African sites covering five countries (Kenya, Uganda, Ethiopia, Senegal and Burkina Faso), and we assess the potential to increase food supply and reduce emission intensities, as a result of closing these yield gaps. We use stochastic frontier analysis (SFA) and data envelopment analysis (DEA) to construct production frontiers for each site, based on 2012 survey data from the CGIAR CCAFS research program. Instead of relying on theoretically optimal yields, which is commonplace in yield gaps assessments, our yield gaps are based on observed differences in productivity among farms within each site. Accordingly, we are able to identify more plausible pathways of improvement, based on better use of existing technology. Significant yield gaps were estimated to be present in all of the sites from each of the five countries. Expressed as potential percentage increases in outputs, the yield gaps ranged from 54% to 179%, depending on the site and the methodology. Through closing these yield gaps, we estimate corresponding reductions in the emission intensity of food supply, of between 35% and 64%. Market orientation (*i.e.* proportion of outputs sold) and asset wealth were significantly and positively correlated with productivity across most sites, while farmer age and off-farm income tended to be negatively correlated with productivity. These findings can help improve the targeting of extension and investment efforts to close yield gaps, improve farmer livelihoods and environmental performance.

17:15 Potential for taking climate smart agricultural practices to scale: examples from Sub-Saharan Africa

Tesfaye Kindie[1], Cairns E. Jill[2], Misiko Michael[1], Stirling Clare[3], Abate Tsedeke[4], Prasanna B.M.[4], Mekuria Mulugeta[4]

[1]*International Maize and Wheat Improvement Center (CIMMYT), Addis Ababa, Ethiopia*

[2]*CIMMYT, Harare, Zimbabwe*

[3]*CIMMYT, London, United Kingdom*

[4]*CIMMYT, Nairobi, Kenya*

Agriculture in Sub-Saharan Africa (SSA) is predominantly rainfed and smallholder farmers (>80%) are the primary producers of agricultural outputs in the region. Erratic weather patterns and extreme weather events exacerbated by the changing climate adds to the challenges faced by smallholder farmers in producing enough food to feed the ever growing population of the region. While the farming communities are responding to these challenges, there is an intensive need for scaling-up adoption of appropriate interventions that can help increase crop yields and resilience to climate change. A review and analysis of potential climate-smart agricultural practices (CSAs) in SSA indicate that some CSAs are increasingly adopted by farmers and show potential for scaling-out more than others. Some of these practices include drought tolerant (DT) maize varieties, water harvesting and small-scale irrigation, crop associations, and climate information and natural resource conservation. For example, about 160 drought DT maize varieties have been released in 13 SSA countries during 2007-2013 and a large number (>91) of African seed companies are producing and marketing seed of these varieties to smallholders. Nearly 2 million hectares are estimated to have DT maize varieties planted every year, benefiting more than 3 million smallholder households. The number of farmers that harvest water and grow short maturing crops (*e.g.*, 'green maize') and vegetables using small-irrigation in Ethiopia is increasing by 0.6 million farmers every year. Crop associations, particularly intercropping of cereals and legumes (*e.g.*, maize and legumes), are expanding in the farming systems of eastern and southern Africa. The demand for seasonal and intra-seasonal climate information has increased in some countries such as Ethiopia and Mali where farmers who received and applied integrated climate information increased their farm income by 10-80% compared to those who did not receive the information. Farmers in SSA are also widely involved in large-scale off-season soil and water conservation practices (*e.g.*, Ethiopia), afforestation (*e.g.*, Kenya, Ethiopia) and agroforestry practices (many countries). The presence of some successful smallholder CSA practices in SSA means that opportunities exist for cross-country learning and scaling-out by supporting farmers' efforts through policies, incentives and exchange of knowledge.

This work is supported by the CGIAR Program on Climate Change, Agriculture and Food Security (CCAFS).

Parallel session L1.2
Australasia

Monday, 16 March 2015

14:00–18:00

ROOM SULLY 2

KEYNOTE PRESENTATIONS

14:00 Climate-smart agriculture in South Asia: opportunities and constraints in scaling out

Aggarwal Pramod[1], Kahtri-Chettri Arun[1], Bhaskar Shirsath P.[1], Jat M.L.[2], Joshi P.K.[3]

[1]*CGIAR Research Program on Climate Change, Agriculture and Food Security, International Water Management Institute, New Delhi-110012, India*

[2]*CIMMYT, New Delhi-110012, India*

[3]*IFPRI, New Delhi-110012, India*

South Asia comes across as amongst the most vulnerable regions to climate change in the Inter-government Panel on Climate Change (IPCC)'s Fifth Assessment Report released a year ago, and in other similar reports. Climate change in the region is manifested by depleting glaciers, increasing coastal erosion, frequent heat waves, rising sea level, frequent floods and droughts and varying rainfall patterns. It is now evident that South Asia's climate is already changing and the impacts are already being felt. As a largely agrarian economy, this vulnerability is compounded by the fact that more than 700 million people's livelihoods depend on agriculture directly influenced by changes in climate.

Although South Asia has seen robust economic growth, with the GDP averaging about 6 percent over the past 20 years, the region is still home to 1/4th of the world's hungry and 40% of the world's malnourished children and women. As populations continue to rise and the demand for food grows, the question is: how will this increase in demand be met and where will all this food be grown? With stiff competition for land from the non-farm sector, expanding farmlands is not an option. Climate change will further exacerbate the existing pressures on land and water resources. If the second Sustainable Development Goal of ending poverty, achieving food security and promoting sustainable agriculture is to be realised, climate change adaptation and mitigation technologies, practices, services and policies will need to be implemented in earnest.

Many recent studies show a probability of 10-40 percent loss in crop production by 2070-2100 on account of rising temperatures and decrease in irrigation water, unless steps are initiated now to increase our adaptive capacity. For example, even with the benefits of carbon fertilization (which could anyway be negatively affected by increase in surface ozone concentration) India stands to lose nearly 4-5 tonnes of wheat with every rise in temperature of 1 degree Celsius. This estimate could be even higher when decrease in irrigation is factored in. Wheat losses could be significant even in the short term, while losses for other crops are uncertain and estimated to be relatively smaller, particularly so for monsoon crops. Similarly, there are studies to show that livestock and fish productivity could also decline.

Climate change does offer some opportunities as well. One adaptive measure is to identify regions that would become conducive for certain crops in the changed climate. For example, farmers in the upper regions of Himachal Pradesh in India have taken to growing apples because temperatures in the lower regions became too warm for its growth. The shift in cultivation brought new opportunities and high incomes for these farmers while their counterparts in the south switched to cultivating vegetables.

It is clear that per hectare cultivation of food needs to drastically increase to meet growing food demands. While this is a challenge, the existing large crop yield gaps in the region suggest there is potential to increase crop production per hectare even in the face of increasing climatic risks. For this to happen, investments in land and water management, infrastructure, and research accompanied by enabling policies, sustained regional cooperation and robust institutions is crucial.

Increased production variability could perhaps be the most significant impact of global impact change in Asian countries. Short-term changes in weather extremes, which are still not very predictable in most countries of the region, pose huge challenges. Some recent examples are the drought in 2014, the floods in Pakistan in

2010, floods in India, Nepal and Bangladesh in 2007 and the heat-stress experiences in India in 2004 which resulted in fluctuating yields, food price volatility and threatened food security and incomes. Such volatility is despite the vast irrigation network in the region, especially in the Indo-Gangetic plains. During last few decades, excessive groundwater extraction has resulted in widespread decline in water table and water quality degradation. To ensure future food security in climate change scenarios, investment in managing and stabilizing the existing irrigated potential while exploring options to expand this potential is the need of the hour.

Several technological, institutional and policy interventions have been proposed that can help us adapt to climate change as well as to current and future weather variability. These include simple adaptation practices such as changes in planting dates and crop varieties. Additional strategies that have been proposed include: the deployment of adverse climate tolerant genotypes and diversified land use systems, the use of solar irrigation, assisting farmers in coping with current climatic risks through providing weather linked value-added advisory services and crop/weather insurance, and improved land and water use management and policies.

Agriculture in South Asia contributes between 15-20 percent to total greenhouse gas emissions. These are primarily from enteric fermentation in ruminant animals, rice paddy cultivation, and nitrous oxide from manures and fertilizers application to soils. What is interesting to note is that most of the proposed adaptation options, if implemented scientifically, come with large mitigation co-benefits.

CCAFS is scaling out the Climate-Smart Villages (CSVs) model in several countries, including in South Asia, to promote climate-smart agriculture (CSA). Climate Smart Villages are sites where a portfolio of the most appropriate technological and institutional interventions, determined by the local community, are implemented to increase food production, enhance adaptive capacity and reduce emissions. Interventions are bespoke to each village but the concept lends itself to be applied in any region under the right circumstances. Initial results suggest a large potential to maximise synergies among different interventions in order to scale out CSA. Much work needs to be done to expand the evidence base of CSVs with regard to targeting the approach in different agro-climates, the costs: benefit analysis in terms of investment and returns, and the institutional and policy changes that are needed to promote CSA.

In the South Asia region, problems of widespread poverty, poor governance, weak institutions, and human capital limit agricultural growth today. These problems can also reduce the potential of adaptation strategies. It is critical to simultaneously address these political and socio-economic constraints if the full potential of CSA is to be realised for farmers and the region as a whole.

14:30 Promotion of climate resiliency for food security in the association of Southeast Asian nations: regional policy making and funding opportunities

Bacudo Imelda

ASEAN-German Programme on Response to Climate Change, GAPCC
GIZ Jakarta[1]

Southeast Asia (SEA) is one of the world's most vulnerable regions to climate change, due to its long coastlines, high concentration of population and economic activity in coastal areas, and heavy reliance on agriculture, fisheries, forestry and other natural resources[2]. Climate change threatens agricultural production and indirectly food security, ecological stability, and sustainable development. Since the global food crisis of 2007 / 08, the Association of Southeast Asian Nations (ASEAN) has made food security a long-standing agenda, and addresses this through the ASEAN Integrated Food Security (AIFS)[3] Framework. Along with the ASEAN Multi-Sectoral Framework on Climate Change (AFCC), both serve as a regional umbrella for food security related initiatives which include emerging threats of climate change.

Since the release of AR4, there has been an increase in adaptation initiatives at various scales, some of them on ensuring food security, within each ASEAN member states. It can be attributed to a number of factors such as increasing awareness brought about by global environmental policies (*e.g.* IPCC, UNFCCC), substantial multilateral and bilateral supports (*e.g.* PPCRV), strategic response of civil society actors to address disasters and emergencies, new funding platforms (*e.g.* Green Climate Fund and Adaptation Fund), and increasing realization among governments that climate change has serious impacts on their citizens and economies.

In this presentation, the experiences of 7 ASEAN member states in adapting to climate change to ensure food security through agriculture are reviewed. In doing so, the concept of adaptation readiness is introduced. The focus, however, is on the assessment of the socio-political and funding support as the enabling environment for each country. More importantly, this presentation presents a discussion of how ASEAN, the institution, has taken regional policy and funding measures in order to achieve the goals of regional economic integration, increased productivity and growth through resilience to the impacts of climate change.

From the review, it appears that promotion of resiliency in agriculture is being approached two ways. First is at the national level which gives an adaptation readiness assessment through sectoral, national and local development plans as frameworks, which in turn mandate initiatives. Here, the level of achievement varies among ASEAN member states. Some countries are way ahead in terms of implementation, while others are catching up. Hence, this is notably the rationale for the creation, for example, of the ASEAN Climate Resilience Network which offers as the platform for the exchange of knowledge, expertise and finance opportunities among the member states. It also offers a platform that bridges science and learnings from actual implementation of climate-smart agriculture back to policy.

The other approach is through the recognition of achieving common goals through regional action. Regional projects with support from international cooperation agencies, such as GIZ, USAID, SDC, AUSAID, JICA, support the policy frameworks that ASEAN has put into effect, such as AIFS and AFCC. Here as well, there are varying levels of engagements, which continue to present opportunities for strengthening policy and opening

[1] With thanks to Albert Salamanca, Research Fellow, Stockholm Environment Institute
[2] The Economics of Climate Change in Southeast Asia: A Regional Review. ADB, Manila, April 2009
[3] ASEAN adopted the AIFS in 2009 and is now in its second phase (2015 – 2020) and includes Climate Smart Agriculture

funding opportunities for the further promotion of climate resiliency within individual countries, and back to the region. As of 2014, no country in ASEAN succeeded in getting an entity accredited as National Implementing Entity (NIE) for the Adaptation Fund. While the global architecture of climate finance is evolving and there are definitely a lot of opportunities for deeper engagement among member states as contributor and recipient of financing, ASEAN should explore the possibility of being accredited as a Regional Implementing Entity (RIE). It occupies a strategic position as a convening agency for 10 countries in Southeast Asia, and it has an existing fiduciary system. This thus widens the options for access by countries in the region, and can also serve as a temporary bridge to access climate funding for urgent priorities while the process of national accreditation is ongoing. Bilateral organizations already working with the ASEAN ASEC, such as the GIZ, could offer support in exploring the risk and opportunities of ASEAN accrediting itself as an RIE.

CONTRIBUTED ORAL PRESENTATIONS

16:30 Integrated rice-shrimp as a smart strategy to cope with climate change in the Mekong Delta, Vietnam

Trinh Q. Tu[1], Tran V. Nhuong[2], Phan T. Lam[3]

[1]Research Institute for Aquaculture No.1 RIA1, Dinh Bang, Tu Son, Bac Ninh, Viet Nam

[2]WorldFish Center (WFC, Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia

[3]Research Institute for Aquaculture No.2 (RIA2), No. 116 Nguyen Dinh Chieu, District 1, Ho Chi Minh City, Viet Nam

Aquaculture is important, supporting incomes and livelihoods of hundred thousand of small scale farmers in the Mekong Delta of Vietnam. With increasing impacts of climate change and other change factors, yields and profits of mono-aquaculture systems in ecologically sensitive areas have been declining. As a result of these negative impacts, many aquaculture farmers in the region have shifted back to integrated farming methods. Rice and shrimp aquaculture in coastal areas in the Mekong Delta is among those integrated farming systems in which rice is farmed in the wet season, and shrimp is farmed extensively or semi-intensively in the dry season (high water salinity). Integrated farming methods can be considered as a climate smart practice to enhance resilience of aquaculture communities to climate change especially to rise of sea level that results in severe salinity intrusion. Based on data and information collected using focus group discussion and in-depth interview methods conducted in My Xuyen district, Soc Trang province, this study evaluated the potential of rice and shrimp aquaculture rotation as a climate smart strategy adopted by local farmers to cope with increasing impacts of climate change (sea level rise and climate variability). Findings showed integrated farming practices, in general, have proved their advantages over other models under impacts of climate change. The integration of dry season shrimp farming into rice fields has significantly raised incomes for farmers in saline affected areas. By integrating shrimp with rice, pond sediments were used to fertilize rice crops, which results in reducing chemical fertilizer use in rice production. In addition, rice crop works as a natural filtration system to minimize risks of disease outbreak for shrimp crops (30% less risk compared to mono-shrimp). Shrimp and rice farming integration also contributed to improving the efficiency of land use, as well as to the reduction of land degradation.

16:45 Changing rainfall pattern in Northeast Thailand and implications for cropping systems adaptation

Lacombe Guillaume[1], Polthanee Anan [2], Jintrawet Attachai [3], Trébuil Guy[4]

[1]*International Water Management Institute (IWMI), Southeast Asia Regional Office, PO Box 4199, Vientiane, Lao PDR*
[2]*Department of Plant Science & Agricultural Resources, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand*
[3]*Center for Agriculture & Resources Systems Research, Faculty of Agriculture, Chiang Mai University, 50000 Chiang Mai, Thailand*
[4]*Centre de coopération Internationale en Recherche Agronomique pour de Développement (CIRAD), UMR Innovation, 34398 Montpellier Cedex 5, France*

In Northeast Thailand, about 80% of the 20 million inhabitants are engaged in rainfed agriculture. Climate vagaries combined with coarse-textured sandy and unevenly distributed saline soils explain low agriculture yields and the endemic relative poverty of the population. We conducted an in-depth analysis of change in the rainfall pattern using daily records (1953-2010) from 18 gauging stations scattered across Northeast Thailand. Based on an intimate knowledge of the local farming systems, particularly their strategies to deal with climate variability and their evolution during the past decades, we analyse and discuss how the cropping systems can adapt to the detected rainfall changes. We used the Mann–Kendall trend detection test, modified to account for serial correlation at each individual station, and the regional average Kendall's statistic designed for the detection of regional trends across the entire studied area. On-farm surveys carried out during the past two decades in both the upper and lower parts of Northeast Thailand provide a detailed understanding of the functioning of the agricultural production systems and their diversity. The analysis reveals very limited changes in rainfall frequency, intensity and extremes during the humid monsoon and therefore little change in the existing climatic constraints to agricultural production (early dry spells in the wet season and risk of floods at its peak in September). But we found a significant regional trend toward a wetter dry season that could offer new limited opportunities for agricultural production. The paper will discuss the implications of these findings and compare them with recently published research results. Differences in statistical significance between local and regional rainfall trends are also interpreted. If these trends extend, households would not face many difficulties because of their renowned adaptive capacity built over centuries of facing highly variable rainfall patterns, and due to the diversity of their resilient farming systems.

17:00 A review of contributions that the System of Rice Intensification (SRI) can make to climate-smart agriculture

Uphoff Norman

SRI-Rice, Cornell University, Ithaca, NY 14853, USA

This paper will review experience around the world with the System of Rice Intensification, developed for irrigated rice production in Madagascar some 30 years ago by a French agronomist-priest, Henri de Laulanié, SJ. Over the past 10 years, SRI concepts and methods have been validated in >50 countries, and governments in China, India, Indonesia, Cambodia and Vietnam, where 2/3 of the world's rice is grown, are now promoting its use. SRI cropping is attractive not only for raising paddy yields with lower costs of production, but because it enables farmers to buffer their crops against climate change hazards (drought, water stress, storm effects, pest and disease damage) while reducing their rice crop's water requirements → adaptation. By stopping the continuous flooding of rice paddies, it also reduces their greenhouse gas emissions, particularly of CH_4 → mitigation. Studies in India, Vietnam, Nepal, Korea and Indonesia have shown no offsetting increases in N_2O, and less on chemical fertilizer for soil fertility enhancement means that carbon emissions from its manufacture and transportation are reduced. SRI methodology is still a work in progress, but it shows promise of contributing greatly to CSA as its ideas and principles are being extended also to rainfed rice production and to other crops like wheat, millet, sugarcane, legumes, tef, mustard, etc. Earlier stereotypes of SRI as 'too labor-intensive' for adoption have proved to be wrong, as SRI methods even become labor-saving for many farmers. In 2013, the number of farmers benefiting from some or all of the recommended SRI methods probably surpassed 10 million, with these methods used on some 3.5 million hectares.

17:15 Development of climate resilient villages

Sikka A.K.[1], Prasad Y.G.[2], Srinivasarao C.H.[2]

[1]*Indian council of agricultural research, New Delhi 110 012, India*

[2]*ICAR-central research institute for dryland agriculture, Santoshnagar, Hyderabad 500059, India*

The National Initiative on Climate Resilient Agriculture (NICRA) of the Indian Council of Agricultural Research selected 130 districts spread across the country based on exposure to climate risks such as drought, floods, cyclone, heat and cold stress. Participatory demonstrations of proven climate resilient practices and technologies were undertaken in farmers' fields in each village. Location-specific interventions were aimed at building resilience to cope with climate variability in crop and livestock production systems through natural resource management (NRM). A total of 1259 NRM interventions in soil moisture conservation, rainwater harvesting and efficient recycling were demonstrated, which resulted in a significant increase in crop yields by about 20-40% in drought situations compared to yields in control farmers' fields. Short duration, drought and flood tolerant varieties in paddy, pulses and oilseed crops were demonstrated in about 2700 ha covering 7831 farmers with adaptation gains ranging from 10 to 31% in stress years. A methodology for assessing and quantifying resilience of resilient practices and technologies to specific climate risks has been developed based on productivity and income in stressed versus normal year. A village climate risk management committee was involved in decision making and management of community support systems, such as custom hiring centres for access to farm machinery for adoption of resilient practices especially by small and marginal farmers. Some of the climate resilient practices and technologies which have been found promising are being mainstreamed into the National Mission for Sustainable Agriculture (NMSA), a flagship initiative of the Indian government, for enhancing productivity and resilience of Indian agriculture in accordance with the stated aim of the National Action Plan for Climate Change (NAPCC). The conceptual and implementation framework of NICRA can be replicated to usher in climate resilient agriculture production systems in other parts of South Asia.

Parallel session L1.3
Latin America

Monday, 16 March 2015

14:00–18:00

ROOM SULLY 3

KEYNOTE PRESENTATIONS

14:00 Are we adapting to climate change? The case of the Chilean agricultural sector

Aldunce Paulina, Lillo G.

Universidad de Chile, Chile

There is no doubt that agriculture is a relevant issue to climate change; on the one hand, it relates not only to economic resources but also to food security. On the other hand, for many, agriculture represents a lifestyle and a livelihood; one third of the world´s population depends upon this activity, and largely corresponds to the most vulnerable portion of the population (FAO, 2014[4]). Two-thirds of the rural population of Latin America and the Caribbean live in poverty; family farming represents 81 percent of the farms in the region and generates between 57 and 77 percent of agricultural employment (FAO, 2014[5]; BID, 2015[6]).

Agricultural production in the region grew at a rate of 1.9 percent between 1961 and 2007, less than the rate of 2.4 percent for OECD countries. Given these figures, there is a need to increase agricultural production by 80 percent by 2050 if we hope to support with the expected 35 percent increase of the region's population (BID, 2015). This represents a challenge, especially under a changing climate, that is and will continue impacting the agricultural sector. Agriculture needs to adapt to new climate conditions, both in order to mitigate negative impacts and to search for and take advantage of opportunities. On the other hand, one of the key messages of the Intergovernmental Panel on Climate Change's (IPCC) most recent report is that effort has been concentrated on mitigation rather than on adaptation. The report also highlights that key for advancing in adaption is learning from our experiences, and to do so is relevant the study of what has been done in terms adaptation strategies, plans and practices. Nevertheless, the IPCC report states that little research focuses on evaluating the latter, particularly within Latin America and the Caribbean. In order to fill this gap, the goal of this study was to investigate the development of climate change adaptation in the agricultural sector in Chile and the most salient enablers and barriers emerging from these experiences. In order to do so, we evaluated the achievements and the implementation process of the National Action Plan for Climate Change (PANCC) 2008-2012, the first formal instrument created in Chile by the government to guide all sectors in responding to climate change. The Chilean climate is gradually evolving toward higher average temperatures, lower rainfalls and more severe droughts, and many farmers in the country might not have enough tools to deal with these changes. The results presented here have the potential to help in guiding future actions.

This study employed a multi-method and interdisciplinary approach. Specific methods included literature review, document analysis, consultation with experts, interviews, on-line surveys, and focus-groups. The interdisciplinary approach incorporated professionals and researches from different disciplines and fields from the start, collaborating to formulate research questions, methodology and methods in order to integrate the variety of views necessary to address such a complex subject. This approach is appropriate for climate change studies, which are far too complex to be addressed from the perspective of a single discipline.

The following paragraphs present preliminary results of ongoing research evaluating the implementation of the PANCC 2008-2012. Given that the Plan´s implementation was initially delayed, our study included the years originally included in the design of the Plan (2008-2012) as well as an extension of the evaluation through 2014.

[4] http://www.fao.org/3/a-i4018s.pdf
[5] http://www.fao.org/docrep/019/i3788s/i3788s.pdf
[6] http://www.iadb.org/es/temas/agricultura/estadisticas-de-la-agricultura-en-america-latina,2342.html

The design of the Plan was divided into three strategic areas, adaptation, mitigation and capacity building, with the agroforestry sector´s relevance primarily focused on adaptation, and with agroforestry representing one of the most relevant sectors considered within the area. The evaluation of the Plan showed that the agroforestry sector was the one that accomplished the greatest and most sustained advancement among all sectors considered for adaptation. Between 2008 and 2014, the country was able: (1) to evaluate agroforestry's vulnerability; (2) to determinate the social impacts of climate change on the sector; (3) to generate a portfolio of adaptation measures; (4) to initiate and maintain some adaptation programs; (5) to generate funds and subsidies to encourage the efficient use of water in agriculture; (6) to develop a National System for Agro-Climatic Risk Management and Agricultural Emergency, which delivers relevant information about weather events to the country's farmers, and (7) to design and release a National Adaptation Plan for Agroforestry. However, the evaluation showed that there are still gaps where progress is needed and opportunities for improvement to adaptation within the sector. These include, for example, breeding of species capable of adapting to new climates; the development of more and better tools for family farming, which are still lacking in national policies and strategies; identifying and building synergies with mitigation actions; and the implementation of adaptive management in order to provide the flexibility necessary to accommodate the uncertainty of climate change, learn lessons from and overcome the barriers emerging during implementation.

The assessment conducted in this study also addressed the major enablers and barriers encountered by different institutions responsible for the implementation of the Plan. The evaluation determined that the most important enablers for institutions responsible for adaptation within the sector were interagency collaboration and concern about climate change, while the most important barriers were limited financial resources, constant change in personnel and short-term vision. The limited access in a timely fashion to resources was the most relevant barrier and a cross-cutting issue for all institutions in all policy domains related to the other sectors.

Chile has advanced a great deal in confronting the challenges of climate change for the agricultural sector; however, there is still a long way to go. The results presented in this study provide helpful insights that inform theory, policy design, and the implementation of climate change adaptation.

14:30 Economic valuation of mangrove´s ecosystem services in Gulf of Nicoya, Costa Rica

Arguedas-Marín Maureen, Cifuentes Miguel, Mercado Leida, Bouroncle Claudia

Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), 7170 CATIE, Turrialba, 30501 Costa Rica

Mangroves provide a variety of ecosystem services such as provision of nursery grounds for fish, sediment and nutrient retention and carbon storage. They provide significant ecological and socio-economic functions to local communities, who depend directly on mangrove forests to extract mollusks and also benefit indirectly from mangroves’ support to coastal fisheries. Gulf of Nicoya is the main fishery center of Costa Rica, with about 1500 artisan fishermen and 800 mollusk extractors.
The main objective of this research was to evaluate the economic importance of ecosystem services provided by mangroves to the communities in Gulf of Nicoya, Costa Rica. Since the importance of ecosystem services to human society has many dimensions the research was carried out in two parts. First, we conducted a perception study on the role of mangroves in people’s livelihoods. Variables of interest were local perception, activities based off of mangroves, actions for management and conservation, and local traditions. Through interviews with key actors, household surveys and focus groups with community leaders, resource users and people from the community we identified what people think about the surrounding mangroves: the changes affecting them, the threats they face, their main uses, their use as sources of community income, local initiatives for mangrove conservation, previous community’s experiences and their traditions and celebrations. Then we conducted an economic valuation of two environmental services: carbon stocks (blue carbon) and extraction of mollusks. Data on carbon sequestration in Gulf of Nicoya’s mangroves and international voluntary markets were used in the first case. Market price was used to calculate the net income generated from the extraction of mollusks. Resource users were surveyed to obtain quantitative data about the harvest frequency, harvest data, and local prices.
People recognize some of the ecosystem services and identify mangrove forests as their source of income. The main concern expressed by people is the increasing contamination of coastal areas and the overexploitation of marine resources. Some communities have begun to guard the forest themselves and are taking advantage of the governmental program “Manos a la Obra” to clean mangrove areas. Others communities have a passive attitude and are not undertaking actions against mangroves’ threats. Based on the estimated net income from mollusks extraction, the mean monthly income per household was calculated to be around $228. The aggregate annual value of the 800 households collecting mangrove products on a regular basis reached $2,188,800.00.

CONTRIBUTED ORAL PRESENTATIONS

16:30 The experience in policy dialogue for agriculture and climate change in LAC countries: an overview

Schlaifer Michel[1], Rodriguez Adrián[2], Meza Laura[3]

[1]*French Embassy – ECLAC, Santiago, Chile*

[2]*ECLAC, Agricultural Development Unit, Santiago, Chile*

[3]*FAO, Santiago, Chile*

Since 2010, ECLAC and FAO, supported by the Regional French Cooperation, have organized a series of regional seminars on agriculture and climate change. This series arose out of a perceived growing interest in climate change in different institutional levels of government in the agricultural sector, as well as the absence, at that time, of forums to promote dialogue and to share experiences about institutional and policy development to address climate change issues in agriculture.

The thematics covered have included institutional issues and innovation (2010), pragmatic public and private initiatives on mitigation and adaptation (2011), use of new technologies in agriculture mitigation and adaptation (2012), economics and modelling agriculture adaptation (2013) and agro-biodiversity, family farming and climate change (2014).

The document summarizes the main conclusions and recommendations that have come out of each seminar, organized along three main topics: institutional and policy issues; research and innovation; and information and communication. It also assesses lessons learnt on the conduct of multi-stakeholder policy dialogues for agriculture and climate change and identifies the incidence of the seminars in influencing institutional and policy development for agriculture and climate change in LAC.

The analysis stresses the importance that climate change has gained in the agricultural policy agenda in the region. Recurrent issues that have emerged and of interest for low carbon agriculture include strengthening cross-sectoral policy coordination; highlighting that climate change is a problem of today, not of the future; making explicit uncertainty in modeling exercises; promoting regional collaboration, partnerships and exchange of lessons learnt; strengthening linkages between mitigation and adaptation; the need for better communication among scientists, policymakers and farmers and their organizations; building resilience as the goal of adaptation and a focus on the vulnerability of small scale family agriculture, without disregard for commercial agriculture; and the need to preserve agro-biodiversity.

16:45 Implications of losing the complementariness of gender roles on CSA strategies in the Peruvian Altiplano

Turin Cecilia[1,2], Valdivia Roberto[1], Quiroz Roberto[1,2], Mares Victor[1,2]

[1]*International Potato Center (CIP), Global Program on Crop Systems Intensification and Climate Change (CSI-CC), Lima, Peru*
[2]*CGIAR Research Program on Climate Change, Agriculture and Food Security (CRP CCAFS)*

Potato small farmers of the Peruvian Altiplano manage a set of CSA strategies to cope with climatic and market variability risks and uncertainties to increase their chances to succeed in meeting their food security demands. They have a diversified agricultural portfolio, plant a large mixture of landraces tolerant to different climate stresses, practice staggered planting in at least three stages and strategically manage microclimatic niches and landscapes. Those strategies rely on complex social networks and local knowledge systems where the complementariness of gender roles is crucial for the practice, continuation and sustainability of the faming system. Notwithstanding, climate change and migration have affected the gender roles with differentiated effects. This study explores the implications of the loss of complementariness of gender roles on CSA strategies and on women's adaptive capacity in potato-based farming systems. Data was extracted from databases of R&D projects carried out by CIP and partners for about 20 years in 40 rural communities of the area and complemented with interviews with key informants. We found that migration not only reduced the access to men's labor, impeding the continuation of CSA strategies, but also have interrupted the provision of climate information which was men's domain and important in making farming decisions. Women have started substituting men's roles but with difficulties given the limited access to climate information and to women-oriented technologies affecting the continuation of CSA strategies and their adaptive capacity. Climate change on the other hand, increases women's stress and vulnerability, driving them to opt for less sustainable strategies like moving crops up the highlands where soils are rich in carbon stocks or increasing the livestock component of the system affecting their diverse portfolio and biodiversity conservation. Programs and policies for climate change adaptation are not capturing this dimension and need to improve.

17:00 How do coffee farmers adapt to perceived changes in climate? Evidence from Central America

Saborio-Rodriguez Milagro[1,2], Alpizar Francisco[1], Harvey Celia[3], Martínez Ruth M.[3], Vignola Raffaele[1]

[1]*CATIE, Apdo 7170, Turrialba, Costa Rica*

[2]*University of Costa Rica, 11501, San Pedro de Montes de Oca, Costa Rica*

[3]*Conservation International, Arlington, VA 22202, USA*

Two central questions about agricultural adaptation to climate change are whether farmers are already perceiving changes in climate and what practices, if any, they are implementing or modifying in response to their perceptions. Little is known about the answers to these questions for coffee farmers in Central America, where coffee production is an important source of income and employment. In a household survey, we asked coffee farmers in four landscapes, located in three countries (Guatemala, Honduras and Costa Rica) what changes they had perceived in climate and what changes, if any, they had made in the management of their coffee plantations. The majority of coffee farmers, 97% out of 514 farmers surveyed, said that they have perceived changes in climate, with 94% reporting changes in temperature and 91% reporting changes in rainfall. Changes in farming practices, were reported by 60% of coffee farmers. The most common adaptation practices included are coffee shade, soil conservation, and increased use of fertilizer. However, the use of different adaptation strategies varied across landscapes. In this research, we complement an in-depth description of these results with multivariable analyses of how farm and household characteristics, as well as perceived impacts of climate on welfare indicators (production and income), are related to adaptation. Preliminarily, we found that climatic variables, wealth indicators, access to information, and perceived impacts of climate on welfare indicators are relevant for understanding the adaptation decisions of coffee farmers. With this research, we use current adaptation decisions to shed some light on coffee farmers´ future adaptation strategies. Also, we identify gaps in public policy that prevent some adaptation options from being used more extensively.

17:15 Practices and enabling conditions for climate-smart agriculture: current status in seven countries in Latin America

Bouroncle Claudia[1], Corner-Dolloff Caitlin[2], Halliday Andrew[3], Nowak Andreea[2], Zavariz Beatriz[2], Argote Karolina[2], Baca Maria[4] Fallot Abigail[1,5], Le Coq Jean-Francois[5]

[1]*CATIE-Climate Change and Watershed Program; 30501 Turrialba, Costa Rica*

[2]*CIAT-DAPA, Cali, Colombia*

[3]*CATIE, consultant*

[4]*CIAT-DATA, consultant*

[5]*CIRAD UMR ART-DEV, 34000 Montpellier, France*

Climate Smart Agriculture (CSA) initiatives require that tradeoffs and synergies between three goals - production, adaptation and mitigation – be addressed, in contexts with contrasting challenges. Cross country evaluation of the climate smart practices implemented in the main productive systems of seven countries of Latin America and the Caribbean shows that they have reached different achievement levels in their environmental and socio-economic dimensions. While it is clear that existing sustainable development initiatives have facilitated the adoption of climate-smart practices, the enabling conditions for their dissemination and long-term viability have not been established. We carried out a meta-analysis of the type of climate smart-practices identified in the seven countries and the conditions that enabled their adoption and development. On the basis of an expert-based typology of climate-smartness, we determined degrees of adoption of climate-smart measures, and challenges for their wider implementation as perceived by main stakeholders in the agricultural sector. Then, we reviewed the biophysical, institutional and political context and identified which elements induced the adoption of smart-practices and which tend to block them. We conclude by highlighting some differences between CSA and standard rural development, calling for renewed policy action.

Parallel session L1.4
Europe

Monday, 16 March 2015

14:00–18:00

ROOM RONDELET

KEYNOTE PRESENTATIONS

14:00 EU-funded research & innovation activities in support to Climate Smart Agriculture

Kolar Patrik

Head of Unit "Agri-food Chain", DG Research and Innovation, European Commission, Pl. Rogier 16, BE-1049 Brussels, Belgium

The European agricultural sector is facing a challenging period seeking solutions to the crucial question: How can European agriculture produce good quality food, feed and biomass with minimum negative effects on the environment and on climate change and remain competitive on the global market?

In order to address this question, the concept of a Climate Smart Agriculture (CSA) has been recently proposed to help farmers meet increasing demand for agri-products within the required environmental standards and without losing economic benefits. Moving to CSA is a dynamic process reshaping the role of the farmers and transforming them from simple producers of food and commodities into "wise managers of the natural capital".

This transformation needs to be supported by two strong pillars: policy/legislation and research & innovation. The new Common Agricultural Policy has been revised to accompany the farmers during the transition by shifting subsidies from direct payments (to production) to environmental services. Concerning the role of research, considering that in Europe food self-sufficiency has been achieved, the main contribution that science can give to agriculture should be rather oriented to improving the sustainability of agricultural practices by exploiting more wisely the available natural resources and their full potential. Researchers should help farmers tackle the main challenge of the future: "how to produce enough (or more) food, feed and biomaterials without overexploiting water and soil, without polluting the environment and contributing to Climate Change mitigation".

To tackle this challenge, farmers need access to new knowledge, innovation and technical tools to allow them to meet both policy requirements and economic viability

The large-scale adoption of CSA will certainly benefit from embedding strong elements of Climate Change mitigation and adaptation in all the relevant research programmes and activities aimed at improving agricultural production.

The integration of classical agronomic research with modern biotechnology, information technology, bioinformatics, Agri-engineering and satellite information systems, together with the involvement of other stakeholders, such as farmers, farmers' associations and policy-makers in a true multi-actor approach, will certainly contribute to the building and improving of a new agricultural sustainability in a harmonised rural development context. A CSA based on an enhanced efficiency of crops, animals and growing or breeding techniques, in Europe and world-wide, will be successful only if and when farmers can have easy access to technological advances, innovation and research outcomes. Crucial to the success and adoption of CSA by farmers is the effective and efficient exchange of knowledge and information between researchers and end-users. Aimed at filling this gap, the recently launched European Innovation Partnership "Agricultural Productivity and Sustainability" (EIP-AGRI), will be one of the major players in promoting a dialogue between the researchers and the end-users.

The inter-relations between agriculture and Climate Change were already reflected in many research activities under the 7th EU Research Framework Programme (FP7: 2007 – 2013), which already tackled the problems related to the increasing global demand for food and biomass, especially within FP7 Theme 2 (The knowledge Based Bio-Economy (KBBE)). Although not a primary concern in KBBE, several Climate Change related aspects, such as GHGs emissions and carbon cycle, are present in many FP7 projects, especially in those aimed at promoting sustainable and more resilient primary production systems. Within FP7, several research actions and projects have been launched to improve the use of natural resources in agriculture, livestock and forestry, with particular attention to water, soil, genetic resources and GHGs emissions in a Climate Change context.

Concerning the use of water in agriculture, the issue was mainly tackled by improving crops' drought resistance and by enhancing water use efficiency in irrigated crop production systems. Plant breeding projects addressing abiotic stress resistance in major crops have been funded, *e.g.* PGRSECURE, on exploitation of wild crops' genetic resources as a basis for improved crop breeding as a means of underpinning European food security in the face of Climate Change; DROPS, whose aim was to build drought resistance; MODEXTREME, with the goal of helping European and non-European agriculture to face extreme climatic events by improving biophysical models simulating vegetation responses to extreme climatic events.

On a more agronomic and technological aspect, projects such as SIRRIMED, EAU4FOOD and FIGARO, are aimed at improving water productivity at farm level by developing, testing and applying in the field innovative and precision technologies in combination with agronomic techniques.

Several projects have also been funded to tackle soil management issues related to mitigation and adaptation to Climate Change, such as SMARTSOIL and CATCH-C, with the objective to identify and promote the best farming practices to preserve soil functions and fertility, improve production and reduce Carbon and Nitrogen emissions.

In the area of livestock production, a series of actions addressed both animal management strategies and breeding solutions, with projects such as AnimalChange, NEXTGEN and REDNEX, aimed at mitigation and adaptation options for sustainable livestock production under climate change, and looking for methods to preserve farm animal biodiversity and improve sector resilience to environmental and climatic constraints.

In addition to the above-mentioned examples of projects, during FP7 additional actions have been launched to create suitable conditions and launch supporting instruments to address agricultural production and Climate Change related issues to a more broad and integrated extent at European and Regional levels. For example, the ERA-NETs ARIMNet2 (A Network for Agricultural Research in the Mediterranean Area) and RURAGRI (Facing sustainability: new relationships between rural areas and agriculture in Europe), and the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI).

In the new EU Framework Programme for Research and Innovation - "The Horizon 2020" (2014-2020), the attention to Climate Change aspects has been even reinforced as a transversal important element which is present in almost all the sub-programmes and Societal Challenges. Research activities in support of sustainable – and Climate Smart, Agriculture are the integral part of Societal Challenge 2 (SC2) "Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy". The main aim of SC2 is to secure sufficient supplies of safe, healthy and high quality food and other bio-based products, by developing productive, sustainable and resource-efficient primary production systems, fostering related ecosystem services and the recovery of biological diversity, alongside competitive and low-carbon supply, processing and marketing chains.

Within the first Horizon 2020 SC2 calls (2014 – 2015) several topics addressed the activities in support of Climate Change mitigation and adaptation in relation to agriculture, at European, Regional and International levels. The published call included topics addressing the following areas: Genetics, nutrition and alternative feed sources for terrestrial livestock production; External nutrient inputs; Soil management, quality and functions and Sustainable intensification of agro-food systems in Africa. The first call included also some ERA-NET Co-fund actions on Sustainable and resilient agriculture for food and non-food systems; Sustainable livestock production and Monitoring and mitigation of agricultural and forestry greenhouse gases (GHG).

14:30 FACCE-JPI: a European partnering initiative to tackle food security and climate change – one of the greatest societal challenges

Gøtke Niels

Chair of the FACCE-JPI Governing Board

1. What is Joint Programming and why FACCE-JPI?

FACCE – JPI, the Joint Programming Initiative on Agriculture, Food Security and Climate Change was among the first JPIs to be launched by the European Council (October 2010). Today, FACCE – JPI is an initiative bringing together 21 countries that are committed to building an integrated European Research Area addressing the challenges of agriculture, food security and climate change. The process of establishing FACCE-JPI started in late 2008 following the 2nd SCAR Foresight Exercise: New challenges for agricultural research: climate change, food security, rural development, agricultural knowledge systems (1).

Joint Programming Initiatives are intergovernmental European collaborations meant to tackle grand societal challenges that cannot be solved solely on the national level and thus contribute to the realisation of a European Research Area (ERA). Joint Programming is considered as a process that will operate over the long-term. The idea is to motivate European countries to coordinate national research activities, group resources, benefit from complementarities and develop common research agendas. This is expected to help to overcome bottlenecks and provide the long-term, stable research base that is needed to address major societal challenges. Participation in a JPI is on a voluntary basis with variable geometry: partners participate in actions that are in line with their national research priorities.

JPIs are a part of the European approach towards partnering in Research and Innovation, which includes a number of different instruments. In Europe, the partnering approach is seen to be an efficient way to address major societal challenges and strengthen Europe´s competitive position in R&I by building critical mass and facilitating joint vision development and strategic agenda setting.

Partnering brings together European and national level public players in Public-Public partnerships (P2Ps) like ERA-NETs, article 185 initiatives or public and private players in Public-Private Partnerships (PPPs) like Joint Technology Initiatives (JTIs) and the Knowledge and Innovation Communities (KICs).

Compared to the other Partnering initiatives JPIs are unique because they are Member State- driven.

2. What is FACCE-JPI about?

Food and agriculture have from the very beginning been central issues in the European policy agenda, and Europe is a global leader in policy and action to decrease greenhouse gas emissions. Food production in Europe results in significant emissions, but as a net importer of food and agricultural products, Europe causes significant emissions elsewhere.

To respond to the complex interconnected challenge of sustainable agriculture, food security and impacts of climate change, FACCE-JPI in 2012 published its Strategic Research Agenda (2) which includes five interdisciplinary core research themes:

1. Sustainable food security under climate change;

2. Environmentally sustainable growth and intensification of agriculture;
3. Assessing and reducing trade-offs between food production, biodiversity and ecosystem services;
4. Adaptation to climate change;
5. Mitigation of climate change.

On the basis of a mapping exercise and input from the FACCE-JPI Scientific Advisory Board (SAB) and the FACCE-JPI Stakeholder Advisory Board (StAB), in 2013 FACCE established its first Biennial Implementation Plan for 2014-2015 (3). The Implementation Plan is based on three types of actions:

-Aligning of national research, strategies and programmes
-Exploring emerging research areas
-Investing in areas where there is need for greater efforts across Europe

The implementation of the SRA strives to deliver results and show impacts by working together in a smart way to achieve harmonisation around common priorities.

3. International Outreach / working together with other international initiatives

The focus for FACCE is on Europe, but Europe is part of a global system of food production and consumption. The research agenda of Europe in food, agriculture and climate domains has impacts on the global research capacities and creates potentially positive spill-over effects to other regions of the world. Thus, FACCE-JPI must consider its role in a global context and how the global context will affect Europe. FACCE-JPI has contacts and links to many international initiatives, countries outside Europe and international programmes. Among these the following can be mentioned:

• the Global Research Alliance on Agricultural Greenhouse Gases (GRA)
• the Climate Change, Agriculture and Food Security Programme (CCAFS) of the CGIAR
• the Agricultural Model Intercomparison and Improvement Project (AgMIP)
• the Belmont Forum

FACCE has already organised two international calls and other activities with countries outside Europe. In the future, it would be obvious to connect to the Global Alliance on Climate Smart Agriculture (GACSA) and upcoming R&I initiatives around the Mediterranean Basin and Africa.

4. Future priorities

Agriculture will be among the sectors most severely hit by the consequences of climate change but on the other hand agriculture also plays a crucial role in reducing GHG emissions. These issues are essential policy issues in Europe and in many other regions / countries. Therefore there is a need for an increased science/policy dialogue.

FACCE- JPI has to continue to be policy relevant at a European and national level and must continue to provide evidence-based inputs to future strategies and initiatives at a European and at a national level. Policy relevance is important to get a strong commitment and funding.

Forthis, it is important to be connected to relevant international and European initiatives. However, it is also important to be creative and to keep a close eye on innovation and breakthrough technologies, which very often will come from outside the traditional agricultural sector. Environmentally sustainable growth and intensification of agriculture is an area with a lot of potential for new innovative ICT solutions.

Finally it is important that FACCE-JPI can bring its input to the discussions on how to implement the bioeconomy in Europe for which the central question is how to increase and the supply of sustainable biomass.

References

(1) http://ec.europa.eu/research/agriculture/scar/pdf/scar_2nd_foresight_exercise_en.pdf

(2) https://www.faccejpi.com/Media/FACCE-JPI-SRA

(3) https://www.faccejpi.com/Media/Implementation-Plan

CONTRIBUTED ORAL PRESENTATIONS

16:30 Wheat yield sensitivity to climate change across a European transect for a large ensemble of crop models

Pirttioja Nina[1], Carter Timothy R.[1], Fronzek Stefan[1], Bindi Marco[2], Hoffmann Holger[3], Palosuo Taru[4], Ruiz-Ramos Margarita[5], Tao Fulu[4], Trnka Miroslav[6,7], Acutis Marco[8], Asseng Senthold[9], Baranowski Piotr[10], Basso Bruno[11], Bodin Per[12], Buis Samuel[13], Cammarano Davide[14], Deligios Paola[15], Destain Marie-France[16], Dumont Benjamin[16], Ewert Frank[3], Ferrise Roberto[2], François Louis[16], Gaiser Thomas[3], Hlavinka Petr[6,7], Jacquemin Ingrid[16], Kersebaum Kurt Christian[17], Kollas Chris[17], Krzyszczak Jaromir[10], Lorite Ignacio J.[18], Minet Julien[16], Minguez M. Ines[5], Montesino Manuel[19], Moriondo Marco[20], Müller Christoph[21], Nendel Claas[17], Öztürk Isik[22], Perego Alessia[8], Rodríguez Alfredo[5],. Ruane Alex C.[23,24], Ruget Françoise[13], Sanna Mattia[8], Semenov Mikhail[25], Slawinski Cezary[10], Stratonovitch Pierre[25], Supit Iwan[26], Waha Katharina[21], Wang Enli[27], Wu Lianhai[28], Zhao Zhigan[27,29], Rötter Reimund P.[4]

[1]*Finnish Environment Institute (SYKE), 00250 Helsinki, Finland*

[2]*University of Florence, 50144 Florence, Italy*

[3]*INRES, University of Bonn, 53115 Bonn, Germany*

[4]*Luke Natural Resources Institute, 00790 Helsinki, Finland*

[5]*Universidad Politecnica de Madrid, 28040 Madrid, Spain*

[6]*Institute of Agrosystems and Bioclimatology, Mendel University in Brno, Brno 613 00, Czech Republic*

[7]*Global Change Research Centre AS CR, 603 00 Brno, Czech Republic*

[8]*University of Milan, 20133 Milan, Italy*

[9]*University of Florida, Gainesville, FL 32611, USA*

[10]*Institute of Agrophysics, Polish Academy of Sciences, 20-290 Lublin, Poland*

[11]*Michigan State University, East Lansing, MI 48824, USA*

[12]*Lund University, 223 62 Lund, Sweden*

[13]*INRA, UMR 1114 EMMAH, F-84914 Avignon, France*

[14]*James Hutton Institute, Invergowrie, Dundee, DD2 5DA, Scotland*

[15]*University of Sassari, 07100 Sassari, Italy*

[16]*Université de Liège, 4000 Liège, Belgium*

[17]*Leibniz Centre for Agricultural Landscape Research (ZALF), 15374 Müncheberg, Germany*

[18]*IFAPA Junta de Andalucia, 14004 Córdoba, Spain*

[19]*University of Copenhagen, 2630 Taastrup, Denmark*

[20]*CNR-IBIMET, 50145 Florence, Italy*

[21]*Potsdam Institute for Climate Impact Research, 14473 Potsdam, Germany*

[22]*Aarhus University, 8830 Tjele, Denmark*

[23]*NASA Goddard Institute for Space Studies, New York, NY 10025, USA*

[24]*Columbia University Center for Climate Systems Research, New York, NY 10025, USA*

[25]*Rothamsted Research, Harpenden, Herts, AL5 2JQ, United Kingdom*

[26]*Wageningen University, 6700 AA Wageningen, The Netherlands*

[27]*CSIRO Agriculture Flagship, 2601 Canberra, Australia*

[28]*Rothamsted Research, North Wyke, Okehampton EX20 2SB, United Kingdom*

[29]*China Agricultural University, 100094 Beijing, China*

The sensitivity of a 26-member ensemble of process-based wheat simulation models to perturbations in baseline temperature and precipitation was examined to construct impact response surfaces (IRS) of simulated yields. These show the yield response of the models to systematic changes to the 1981-2010 baseline in temperature (ranging from -2 to +9°C) and precipitation (-50 to +50%). IRSs were calculated for spring and winter wheat yields at four contrasting sites in Europe: southern Finland, Germany (winter wheat in the west; spring wheat in the east) and north-eastern Spain. Simplified assumptions were made about CO_2 level, management and soils with the aim to distinguish differences in model response attributable to climate. Results indicate that the simulated absolute yield levels vary considerably between models under baseline and perturbed conditions. Across the ensemble, there is general agreement among models that the dominant sensitivity shifts from north to south along the transect. Hence, wheat yields are more sensitive to temperature changes at the Finnish site, sensitive to a combination of temperature and precipitation at the German sites, and more sensitive to precipitation at the Spanish site. Yields benefit from cooling at the latter sites, while temperatures are close to optimal for the baseline in Finland. Reasons for these site-specific patterns of response can be inferred, in part, from differences in baseline climate, soils, local cultivars and management practices. Standardized anomalies of annual modelled yields match observed regional yield anomalies more closely for spring wheat in Germany than at other sites, due in part to better resolved observations. The IRS approach offers promise in portraying model behaviour under changing climate, as well as other advantages for analysing and comparing results from multi-model ensemble simulations.

This study was conducted in the FACCE-JPI project MACSUR funded by the EC and national funding agencies.

16:45 Economic assessment of greenhouse gas mitigation on livestock farms

Eory Vera[1], Faverdin Philippe[2], O'Brien Donal[3]

[1]*Scotland's Rural College (SRUC), Land Economy, Environment & Society, EH9 3JG, Edinburgh, United Kingdom*

[2]*INRA, UMR Physiologie, Environnement et Génétique pour l'Animal et les Systèmes d'Élevage, F-35000 Rennes, France*

[3]*Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co Cork, Ireland*

One of the main challenges of livestock production is to reduce its environmental burden while meeting the increased demand for animal products in a changing climate. A wide range of management practices and technologies are available to reduce greenhouse gas (GHG) emissions from European livestock farms. The variability in environmental, financial and management conditions of the farms inevitably leads to differences in the applicability, mitigation potential and costs of these options. Economic assessments of GHG mitigation usually consider an 'average' farm in a region or country, without the detailed implementation of the options on individual farms. This paper is presenting an economic assessment of mitigation options as implemented on two modelled livestock farms: a continental dairy mixed farm (France) and a maritime grassland based dairy farm (Ireland). The mitigation options include cover crops, legumes, nitrification inhibitors, fat and nitrate feeding, and genetic improvement of livestock. The biophysical aspects of the farms were modelled in FarmAC, a deterministic farm model, in a related work. This provided data on production, GHG and ammonia emissions and nitrogen leaching for the baseline and the mitigation scenarios. The corresponding net technical costs were calculated to reflect the management changes required for implementing the mitigation options, and included changes in resource costs, labour and income. The net technical costs of the options were compared to the greenhouse gas emission changes to calculate the cost-effectiveness of the mitigation options. Results rank the mitigation options in terms of their cost-effectiveness and highlight the differences between the two farms. The divergent practical implementation of the mitigation options is discussed, focusing on the variability in cost elements and abatement potential, and emphasising the need for individually tailored mitigation advice for farmers.

17:00 Agricultural adaptation to climate change in the European Union

Trapp Natalie, Schneider Uwe A.

Universität Hamburg, KlimaCampus, Research Unit Sustainability and Global Change, Grindelberg 5, 20144 Hamburg, Germany

This study assesses the impacts of climate change on agriculture and the value of major adaptation strategies at the farm and policy levels. It extends previous research by (i) using an integrated approach which combines statistical models with a partial equilibrium model, (ii) linking detailed farm level data for the entire European Union to international agricultural commodity markets of global scope and (iii) simulating trade and biomass policies simultaneously in order to gain insight into potential interdependencies and land use feedbacks.
The model demonstrates that negative impacts of climate change can be largely mitigated by a combination of different adaptation strategies and by shifting food crop production to Northern Europe. However, large-scale bioenergy production, as targeted by the EU, induces competition between food and bioenergy crops for scarce land: up to 30% less of the agricultural area is used for food commodities. In the scenarios, welfare increases substantially if trade is liberalised under the assumption that bioenergy does not generate negative environmental externalities (*e.g.* carbon emissions from land use change). To approximate the external costs of bioenergy production, a net import quota is implemented. The results from this trade policy experiment show much stronger welfare impacts.

17:15 Legume supported cropping systems for Europe (Legume Futures)

Rees R.M.[1], Stoddard, F.[2], Iannetta, P.[3], Williams, M.[4], Zander, P.[5], Murphy-Bokern, D.[6], Topp, C.F.E.[1], Watson, C.A.[1]

[1]*Scotland's Rural College, Edinburgh EH9 3JG, United Kingdom*

[2]*Department of Agricultural Sciences, 00014 University of Helsinki, Finland*

[3]*James Hutton Institute, Dundee, United Kingdom*

[4]*Department of Botany, Trinity College Dublin, Ireland*

[5]*Leibniz Centre for Agricultural Landscape Research (ZALF), 15374 Müncheberg, Germany*

[6]*Lohne, 49393 Germany*

Using an extensive network of 18 case studies in 12 countries, the Legume Futures project has evaluated the climate benefits (in terms of mitigation and adaptation) of the cultivation of legumes in European farming systems. Using five contrasting regions of Europe, a rigorous analysis of existing and new rotational designs was undertaken to explore the economic and agronomic implications of new system designs. In the majority of cases, rotations that included legumes were more profitable than those that did not. Cereals following a legume crop can yield up to 25% more than continuous cereals although the magnitude of this effect varies with species. The greatest effects of introducing legumes were seen in areas which have predominantly cereal based rotations *e.g.* Poland, and Northern Italy. The case for expanding legume production in Europe is commonly based upon supposed environmental benefits. Estimates of biological nitrogen fixation (BNF) by legume crops across Europe has shown that 811 Gg of N was fixed in the EU27 by agricultural legumes in 2009. The total amount of N fixed by forage legumes was 586 Gg, comprising 414 Gg from permanent pastures and 172 Gg from temporary pastures. For grain legumes, the total fixation was 225 Gg. The losses of nitrous oxide from legume and non-legume based systems were studied in both forage and grain legumes by measuring N_2O emissions across a range of sites. We have demonstrated that the use of legumes (both grain and forage) within farming systems can significantly reduce N_2O emissions and emission intensities. The overall average emission factor for nitrogen fixed by legumes was 0.14 % resulting in an annual flux of N_2O of 0.41 kg N_2O-N ha^{-1} for faba bean and 0.54 kg N_2O-N ha^{-1} for peas. This is approximately 40 to 50% of the default background flux of N_2O used by the IPCC to account for mineralization of crop residues and atmospheric deposition.

Parallel session L1.5
North America

Monday, 16 March 2015

14:00–18:00

ROOM BARTHEZ

KEYNOTE PRESENTATIONS

14:00 Building climate smart, sustainable, intensive agriculture for the 21st century and beyond

Walthall Charles[1], Hatfield Jerry[2], Schneider Sally[3], Boggess Mark[4]

[1]*National Program Leader, Natural Resources & Sustainable Agriculture Systems Research*

[2]*Laboratory Director & Supervisory Plant Physiologist, National Laboratory for Agriculture & Environment*

[3]*Deputy Administrator, Natural Resources & Sustainable Agriculture Systems Research*

[4]*Center Director, U.S. Dairy Forage Research Center, USDA Agricultural Research Service*

The remarkable successes of global agriculture have been possible through revolutionary developments and application of science and technology. The industrial revolution brought mechanization to agriculture thus enabling rapid cultivation and harvest on increasingly larger areas of land. The green revolution produced greater quantity and quality of yields through genetics and breeding coupled with improved nutrient management. The information revolution has enabled greater precision of spatial and temporal management decisions via sensing, mapping, and variable rate application technology that are reducing input losses and costs, and increasing the efficiency of input use. Mechanization, genetics, and information technologies continue to evolve to the benefit of producers, consumers, and environmental quality.

Land-use changes from agriculture to urban, soil degradation, and shortages of water and nutrients are raising questions as to the ability of the technological advances of the industrial, green, and information revolutions to sustainably meet demands for food, feed, fiber, and biofuel. This unprecedented need to intensify production is augmented by challenges from changing climate. The agricultural revolutions were made possible because of a long period of stable climate. This stability appears to be coming to an end and agriculture production systems will be exposed to an increasing degree of variation in temperature and precipitation patterns within and among growing seasons. The effects of climate change on agriculture production systems are complex and pose different challenges from those faced by previous generations of producers.

Crop production integrates the soil, climate, and management practices, and stable production among years is dependent upon the producer's ability to understand these interactions. For the purposes of research and decision-making, it is useful to separate environment from management practices, as management can be controlled. By linking management practices with genotype, the interaction of genetics (G) with environment (E) and management (M), (G x E x M), provide a new strategy for developing and implementing agricultural production systems. The rationale for departing from the classic G x E interaction is to highlight the effects of climate variability on the environment factor, and the opportunities for management to enhance performance of genetic resources (potential yield) under varying environmental conditions. With many options for crop management available (tillage and residue practices, crop rotations, cover crops, fertilizer practices, irrigation scheduling, timing of management practices, etc.), one must ask: will different genotypes do better under different management practices for a given set of climatic conditions? This same approach applies to livestock production in being able to understand the role management has in alleviating stresses caused by the environment coupled with the proper genetic selection to reduce the likelihood of detrimental effects of the environment. The G x E x M approach is well-suited to closing the yield gap, the difference between potential yield and farmer yield, as all factors affecting crop yields, and when these factors affect yield during the growing season are addressed.

Manipulation of soil characteristics (physical structure, moisture, nutrient status, biology, etc.) is the focus of most management practices, thus the recent heightened emphasis on soil security and soil health takes on a special importance to G x E x M for intensifying crop production. Conservation practices for erosion control and soil moisture management are mainstays of production practices. The role of soil biology on soil health and the management practices to manipulate soil biology is a promising area of research. Treating soil as a living entity, that if properly nourished, builds and sustains an environment that increases yield quantity and quality while enhancing environmental quality and ecosystem services may be the new paradigm. Nutrient management is advancing beyond applications of inorganic nitrogen, phosphorous, and potassium that have dominated fertilizer practices since the 19th century to a wide variety of options. Different nutrient strategies include encapsulated, slow-release fertilizers, inoculants that enhance beneficial soil biological organisms, organically-based fertilizers, and mixes of inorganic and organic nutrient applications that enhance the health of soil biology and make more forms of nutrition available to the crop. As the science of soil biology advances, insights about the role of soil biology on soil and plant health—including nutrient status, and ways to manipulate soil biology for better yields, environmental quality, and producer economic viability will be developed. These new management practices, when integrated into a G x E x M approach may well provide the foundations for the next revolution in agriculture.

No one institution has all the knowledge or resources needed to ensure that climate smart, sustainable, intensive agriculture becomes a reality for the 21st century. Thus, partnerships between researchers, policy-makers, entrepreneurs, and consumers are essential to success.

14:30 Scientific article summarizing the 2013 CSA Global Science Conference in North America

Jackson Louise E.[1], Steenwerth K.L.[2]

[1]*Department of Land, Air and Water Resources, University of California Davis, USA*

[2]*Crops Pathology and Genetics Research Unit, Agricultural Research Service, United States Department of Agriculture (ARS/USDA), USA*

An open-access article in the journal Agriculture & Food Security summarizes the findings of the 2nd Global Science Conference for Climate-Smart Agriculture (CSA) held in March 2013 at the University of California, Davis. The article, whose preparation was led by UC Davis, reflects the participation of 300 attendees from 35 countries, representing numerous organizations. It recommends objectives that place a stronger emphasis on science that moves knowledge into action and involving researchers in helping communities and societies change and adapt. The citation is:

Climate-Smart Agriculture Global Research Agenda: Scientific Basis for Action (2014) Steenwerth K.L., Hodson A.K., Bloom A.J., Carter M.R., Cattaneo A., Chartres C.J., Hatfield J.L., Henry K., Hopmans J.W., Horwath W.R., Jenkins B.M., Kebreab E., Leemans R., Lipper L., Lubell M.N., Msangi S., Prabhu R., Reynolds M.P., Sandoval Solis S., Sischo W.M., Springborn M., Tittonell P., Wheeler S.M., Vermeulen S.J., Wollenberg E., Jarvis L.S., Jackson L.E., Agriculture & Food Security 3:11, http://www.agricultureandfoodsecurity.com/content/3/1/11

The article was published a few weeks before the establishment of the Global Alliance for Climate-Smart Agriculture on 23 September 2014 at the UN Climate Summit in New York. It may have gained attention due to interest in this highly visible science-policy interface. As of mid-January 2015, it has been accessed more than 8000 times.

The 2013 Conference agenda was strongly based on disciplinary science, and the ways that it can form the basis for actions that provide greenhouse gas mitigation, adaptation, and resilience for food systems and ecosystem services despite the future uncertainty of climate change and extreme events. It built upon the 2011 Global Science Conference on CSA in Wageningen, where participants took stock of global science and best practices concerning climate smart agriculture and agreed on a broad agenda for action for science and policy to strengthen food security, adaptation and mitigation. Statements made at these conferences (Wageningen Declaration and Davis Statement; see links below) provided summaries of priorities for research approaches and transformative actions based on science. But, many felt a need for a comprehensive synthesis of the scientific evidence presented at the 2013 Conference, to serve as both a benchmark and a guide for future CSA research activities.

The co-authors of this article were the leaders of each disciplinary science session at the 2013 Conference: crop and animal physiologists, hydrologists, soil scientists, ecologists, sociologists, political scientists, economists, and geographers. The participants in their sessions were asked to identify knowledge gaps, research initiatives, and transformative actions required to address specific issues. The last section of the article presents broad outcomes and messages about how to structure disciplinary and interdisciplinary science in a CSA context rather than mechanisms for implementing science in action.

The article presented new advancements and key aspects of CSA within three themes:

1. Farm and food systems: genetic and crop physiology improvements; synergies for mitigation and adaptation for crops and livestock; management of climate risk; energy use and biofuels; and reduction in barriers to adoption of CSA practices.
2. Landscape and regional planning: modeling adaptation and uncertainty to enhance natural resources and multifunctional outcomes; stabilize food and fishery systems; protect forest biodiversity and ecosystem services; deal with rural migration, and develop metrics for monitoring.
3. Research design with stakeholders to bridge disciplines and scales to link science, action, and governance.

Imperatives for future scientific work in support of CSA included:

- Models that go beyond impacts to include adaptation and transformation at either farm or landscape levels;
- Capacity approaches for feasible multifunctional solutions that deal with agronomic, environmental, and socio-economic issues;
- Direct evidence and metrics for situations, options, and scenarios that create resilience and build local capital;
- Adoption of new farming technology and practices to avoid risks assumed during the conversion period; and
- Understanding climate effects on the rural labor force, migration, land tenure, and cultural integrity, so as to support local livelihoods and priorities.

Across the different disciplines and scales, consensus was reached on research approaches. Effective research for knowledge-sharing and governance must involve stakeholders. It must deal explicitly with uncertainty, incorporate social benefits along with technological change, go beyond the agricultural sector for problem-solving, and establish climate finance within a green development framework. Social-ecological approaches will help to leverage the local knowledge-to-action processes that are essential for climate preparedness and reduce the development controversies associated with CSA (such as when and why GHG emissions are a priority) to better identify technologies, policies, and approaches for sustainable food systems in a changing climate.

CONTRIBUTED ORAL PRESENTATIONS

16:30 The 4-R nutrient stewardship and its role in climate smart agriculture

Khosla Raj, Longchamps Louis, Reich R.

Department of Soil & Crop Sciences, Colorado State University, Fort Collins, CO, USA

Nitrogen fertilizer is the most widely used nutrient on the planet and the most important contributor of nitrous oxide emissions from agricultural sources. With increasing pressure to produce more food globally, many economies have been increasing nitrogen consumption. The global nitrogen use efficiency estimates are in the proximity of 40%, which indicates that a lion share is lost in the biosphere every year. For farmers to practice climate smart agriculture, enhancement of nitrogen use efficiency is mandated. The 4-R nutrient stewardship is a major breakthrough in addressing the nitrogen challenge. It optimizes the input source, placement, amount, and timing while maximizing output, efficiency, and profitability in a sustainable manner. Long-term research at Colorado State University since 1997 has developed and demonstrated site-specific management zones as an effective tool for climate smart agriculture. This research documented a reduction of up to 46% in nitrogen loadings without impairing grain yields. Coupling site-specific management zones with more recent innovations such as active proximal sensors enables the management of both, macro- and micro-variability in farm-fields and results in further improvement of nitrogen use efficiency and reductions in N loadings in the biosphere. Recent studies conducted under small scale farming systems in China, India, Malaysia, Zimbabwe, Mali, Niger and elsewhere have demonstrated that the benefits of such 4-R nutrient management techniques are scale independent. Increasing N use efficiency with such advanced decision-making process decreases the dependence on fossil fuel costly conversion of N_2 to urea and reduces the unused amounts of nitrates in the field contributing to N_2O emissions.

16:45 From climate variability to climate change: building adaptive capacity among row crop farmers in the Southeastern USA

Ortiz Brenda V.[1], Fraisse Clyde[2], Dourte Daniel[2], Bartels Wendy-Lin[2], Zierden David[3], Knox Pam[4], Risse Mark[4], Vellidis George[4], Templeton Scott[5], Thomas Michel[6]

[1]*Auburn University, Crop, Soil, and Environmental Sciences Department, 36849, Auburn, Alabama, USA*

[2]*University of Florida, Biological and Agricultural Engineering Department, Gainesville, Florida, USA*

[3]*Florida State University, Center for Ocean-Atmospheric Prediction Studies (COAPS), 32310, Tallahassee, Florida, USA*

[4]*University of Georgia, Crop and Soil Sciences Department, 30602, Athens, Georgia, USA*

[5]*Clemson University, Department of Economics, 29631, Clemson, South Carolina, USA*

[6]*Florida A&M University, Department of Agribusiness, 32307, Tallahassee, Florida, USA*

Agricultural food production has been extremely important to the Southeastern USA, not only providing quality food for residents but also contributing to the region's economy. Southeastern agricultural production has always faced threats related to interannual and seasonal changes in climatic conditions; however, different from other regions of the globe there has not been a pronounced warming trend signal. With the goal of increasing resilience to climate variability and change as well as building adaptive capacity among row crop farmers, a regional research and extension project including the states of Alabama, Georgia, Florida, and South Carolina was initiated in 2010 with finding from USDA-NIFA. We believe that strategies for adapting to climate change and variability will become much more accessible when education occurs in the familiar context of climate-related risk management. By using participatory approaches and taking advantages of our established partnerships within the agriculture industry, we are working with producers, extension specialists and agents, and farmers associations on the identification, development and evaluation of climate adaptation strategies with increased change of adaption by producers in the Southeastern USA. This project has four major components: 1) Agricultural Systems research; 2) Extension which involves workshops, field days, participation in farmers' meetings, co-development of extension materials and decision support tools, establishment of learning networks to facilitate and promote engagement between researchers and practitioners in adaptation science; 3) Development of new decision support tools for Agroclimate.org; 4) Policies and Insurance. Major outputs from this project are: establishment of the Tri-state row crops climate learning group, design and establishment of an annual adaptation exchange fair showcasing adaptation strategies to cope with climate-related risks, partnership with stakeholders on identification of adaptation strategies for crops such as wheat and corn, web-based decision support tools targeting drought, planting date optimization, water-carbon-nitrogen foot print, factsheets and videos.

17:00 Climate-Smart Agriculture and Water Management in California

Sandoval Solis Samuel

University of California, Davis One Shields Avenue Davis, California - CA 95616, USA

Climate smart agriculture in not only refers to innovative ways of agricultural practices, but also very creative ways of water resources management. During the last decades, water management in California has evolved to meet multiple societal water uses such water for human consumption, agriculture, environment and flood control. While in the past individual policies were able to accomplish the required systems improvement needed to meet water demands; nowadays water management is integrated by a mosaic of strategies that interact with each other. This presentation will show different water management strategies executed in California, such as water conservation and improving the application efficiency of irrigation systems, as well as conjunctive use of surface water as means of dealing with current and future needs for water. The current drought in California shows that climate smart-agriculture is an alternative to cope with uncertain climate and water availability in an ever growing water demand society.

17:15 Dealing with climate and yield variability: the role of precision agricultural technologies and crop models

Basso Bruno[1], Robertson G. Philip[2], Hatfield Jerry[3]

[1]*Department of Geological Sciences and W.K. Kellogg Biological Station, Michigan State University East Lansing, Michigan 48823, USA*

[2]*Department of Plant, Soil and Microbial Sciences and W.K. Kellogg Biological Station, Michigan State University East Lansing, Michigan 48823, USA*

[3]*National Laboratory for Agriculture and Environment, Ames, Iowa 50011, USA*

One of the primary goals of agricultural management is to increase the amount of crop produced per unit of fertilizer and water used. World record corn yields, this year greater than 28 MT/ha, made crop scientist rethink on the yield limit once set for a corn crop. These high yields have demonstrated that water use efficiency can increase fourfold with improved agronomic management and cultivars able to tolerate high densities. Not all the crop fields reach this level of efficiency, and within-field variability has further illustrated that parts of the field can reach high rate of resource use efficiency while others will not. Planting crops with higher plant density can lead to significant yield increases, and increase plant transpiration vs. soil water evaporation. Recent advances in irrigation technologies coupled with new scheduling algorithm using crop models rather than crop coefficient approaches have led to higher rates of irrigation efficiency and improved water quality.

Precision agriculture technologies have been adopted for the last twenty years but seldom have the data collected been converted to information that lead farmers to different agronomic management. These methods are intuitively appealing, but yield maps and other spatial layers of data need to be properly analyzed and interpreted to truly become valuable.

Current agro-mechanic and geospatial technologies allow us to implement a spatially variable plan for agronomic inputs including seeding rate, cultivars, pesticides, herbicides, fertilizers, and water. Crop models are valuable tools to evaluate the impact of management strategies (*e.g.*, cover crops, tile drains, and genetically-improved cultivars) on yield, soil carbon sequestration, leaching and greenhouse gas emissions. They can help farmers identify adaptation strategies to current and future climate conditions. In this paper we illustrate the key role that precision agriculture technologies (yield mapping technologies, within season soil and crop sensing), crop modeling and weather can play in dealing with the impact of climate variability on agriculture and environmental outcomes. We present case studies to illustrate this concept.

POSTER SESSION 1

Monday, 16 March 2015

15:00 – 16:30

EXHIBITION HALL, LEVEL 0

L1.1 Africa

1. Is conservation agriculture a climate-smart option for smallholders in sub-Saharan Africa?

Bruelle Guillaume[1], Naudin Krishna[2], Scopel Eric[2], Corbeels Marc[2], Torquebiau Emmanuel[2], Penot Eric[3], Rabeharisoa Lilia[4], Mapfumo Paul[5], Tittonell Pablo[6]

[1]*FOFIFA, DP SPAD, 101, Antananarivo, Madagascar*

[2]*CIRAD, UPR AÏDA, 34398, Montpellier, France*

[3]*CIRAD, UMR Innovation, 34398, Montpellier, France*

[4]*Université d'Antananarivo, LRI, 101, Antananarivo, Madagascar*

[5]*University of Zimbabwe, SOFECSA, 00263, Harare, Zimbabwe*

[6]*Wageningen University, FSE, 6708 PB, Wageningen, the Netherlands*

Sub-Saharan Africa (SSA) faces the challenge of developing a climate-smart agriculture (CSA) that simultaneously ensures food security, mitigation and adaption to climate change (CC). Conservation agriculture (CA) is widely promoted in SSA and is considered as a way to meet these CSA objectives. The objective of the study was to assess whether CA in SSA contributes to the three pillars of CSA, seeking evidence from the peer-reviewed literature that compares the performances of CA and conventional tillage-based (CT) cropping systems. The positive yield responses to CA compared to CT are widely documented in SSA. The positive effects on soil fertility result in increased yield in the long term. Yield impacts in the shorter term are variable and depend to a great extent on the climatic context. CA responds better under low and/or erratic rainfall conditions, mainly due to the mulching effect on soil water conservation. This suggests the potential of CA as a cropping strategy to adapt to more variable rainfall in the future as predicted in many regions of SSA. However, an increase in yield does not necessarily translate into an increase in farm income. The economic impact of CA is highly dependent on the socioeconomic context. The potential of CA to mitigate CC remains unclear. Retention of crop residues as mulch may not always translate into soil carbon sequestration. Further studies on the impact of CA on soils' greenhouse gases emissions are needed. In conclusion, the ability of CA to contribute to CSA is very site- and farm-specific, and lies to a great extent in its capacity of retaining crop residues as mulch on the soil surface.

2. From time uncertainties to climate-smart agriculture in the Sudano-Sahelian zone of Cameroon

Fofiri Nzossie Eric Joël[1], Bring[2], Temple Ludovic[3], Wakponou Anselme[4]

[1]*Département de géographie, Université de Ngaoundéré BP 454, Cameroon*

[2]*Département de géographie, Université de Ngaoundéré BP 454, Cameroon*

[3]*Cirad, UMR Innovation, B15, 73 rue JF. Breton 34398 Montpellier, France*

[4]*Département de géographie, Université de Ngaoundéré, BP 454, Cameroon*

In the Sudano-Sahelian zone of Cameroon, the acceleration of drying of landscape has created uncertainty of agricultural practices too related to natural data. The cropping season depends on the climate which is subject to increasingly strong intra annual variability. Farmers' over-reliance on climate results in two major consequences for regional agriculture: replanting in a context of fragility of the seed sector and lower production levels. Public action regarding climate change (erratic rainfall, floods, drought, high temperatures), in the Sudano-Sahelian zone is mainly focused on the preservation of fragile areas (protected areas, reforestation, reducing pressure on the firewood through the promotion of improved stoves). This action is largely supported by international cooperation, and is not compatible with public policies (agriculture, food, land). Also farmers' adaptation strategies to climate change are disconnected from the objectives of innovation and research policies (agricultural intensification, agroecology). The proposed reflection raises the question of the relationship between public policy and farmers' strategies to strengthen the adoption of climate-smart practices that reduce uncertainties. This communication summarizes the results of twenty years of direct observation and field surveys of farmers' perceptions of climate change and environmental degradation. It aims to assess the strategies that farmers have adopted to cope with the new climate and to suggest recommendations for more climatologically smart agricultural practices.

3. Feeding Ethiopia in changing context: from diagnosis to exploration of climate smart options

Mezegebu Getnet[1,2,3], Martin van Ittersum[1], Katrien Descheemaeker[1], Huib Hengsdijk[2]

[1]*Plant Production Systems group, Wageningen University, P.O. Box 430, 6700 AK Wageningen, the Netherlands*

[2]*Plant Research International, Wageningen University and Research, P.O. Box 616, 6700 AP Wageningen, the Netherlands*

[3]*Ethiopian Institute of Agricultural Research, Melkassa Research Centre, P.O. Box 436, Nazareth, Ethiopia*

Claims on land and water have strongly increased in the closed basin of the Central Rift Valley (CRV) of Ethiopia over past decades resulting in over-exploitation of the resources. The declining resource base, the variable and changing climate, low productive cereal systems, and increasing population call for options to improve crop productivity and resource use efficiency to meet the growing demand for food. We examined trends and quantified the plausible recent impacts of climate, land use and irrigation water abstraction changes on basin water availability. We combined large datasets from farmers' (>10,000) and experimental fields to quantify yield gaps (Ygs) (maize and wheat) and analyse the prospects to produce more food. Evapotranspiration from land and water surfaces increased with 205 Mm^3 (1990-2007) associated with the increase in temperature. Approximately 170 Mm^3yr^{-1} (2009) of water abstracted for irrigation was irrecoverably lost. Land use change for cultivation caused a net runoff increase of 260 Mm^3yr^{-1} (1990-2007). Scope for further expansion of cultivated land for more food is limited. However, actual yields in CRV are low, and the average Ygs range between 4.2-9.2 t ha^{-1} (maize), and 2.5-4.7 t ha-[1] (wheat). Annual variability in water-limited yield potential and Ygs is large (2004-2009) while all important management practices were fairly similar. This suggests the need for better understanding of the variability of the climate. We used a crop modelling approach to explore management options under current (1989-2009) and changed climate (2050s). We explored more climate resilient crop management options that can guide future agronomic research and development in Ethiopia. We found that soil and climate specific management options combining nutrient and residue management, cultivar selection and planting density can narrow the Ygs, and help mitigate further land use changes, whereas options perform differently under current and changed climate.

4. Macroalgae as biostimulants of growth and enhance tolerance to Moroccan wheat plants cultivated under salt stress

Latique Salma, Chernane Halima, Mansouri Mounir, El Kaoua Mimoun

Cadi Ayyad University /Department of Biology, Laboratory of Biotechnology, Valorization and Protection of Agro-Resources, Marrakech, Morocco

Abiotic stresses are major constraints on worldwide crop production, and salinity is one of the biggest problems affecting about one-third of the irrigated land on earth (Mengel *et al.* 2001).
Salt stress is a major adverse factor that can lower seed germination and seedlings growth, leading to reduced plant growth and ultimately lower crop productivity in arid and semi-arid regions of the world. In order to improve crop tolerance to this abiotic stress, many research studies have examined the importance of seaweed extract (SWE) in alleviating stress damage to plants.
It has found wide application in modern agriculture for the use of marine macroalgae as fertilizer. Seaweed extracts contain major and minor nutrients, amino acids, vitamins, cytokinins, auxin and abscisic acid which affect growth, yield of plants and tolerance to salt stress. Unlike chemical fertilizers, extracts derived from seaweeds are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animals and birds.
Wheat is a major cereal crop in many parts of the world, especially in Morocco, and is commonly known as king of cereals. Globally, wheat is the second most produced food among the cereal crops after maize and rice. It is a moderately salt-tolerant crop and its yield is substantially reduced as the soil salinity level rises to 100 mM NaCl (Munns *et al*., 2006).
Therefore the aim of the present study were to assess the impact of salt stress on germination and seedling growth parameters of wheat under laboratory and greenhouse conditions and to screen out the impact of Moroccan brown and green algae extract application on wheat tolerance to salt stress.

5. Improving the resilience of fishery stakeholders to the climate change effects. Case of Saint-Louis, Senegal

Diallo Aminata[1], Sarr Benoit[2], Thiao Djiga[3], Sall Moussa[4]

[1]*Centre for Oceanographic Research Dakar,Thiaroye, Senegal (up to october 2O14), Fann Résidence, Dakar, Senegal*

[2]*Agro meteorologist Engineer and Coordinator of Master Climate Change and Sustainable Development Program, Scientific Coordinator of the Global Alliance against Climate Change Project (Regional Centre AGRYMET), Niger*

[3] *Researcher and statistician at the Centre for Oceanographic Research Dakar / Thiaroye, Senegal*

[4] *Regional Coordinator of the MOLOA to the Ecological Monitoring Centre*

Fishing activities play a prominent role in Senegal economy. This important socio-economic sector must however face many constraints such as overfishing and climate change. This study, which aims to analyze the vulnerability of fisheries stakeholders from St. Louis to climate change, has identified the adaptation options that can improve their resilience. To this end, survey interviews were performed with 167 actors. The matrices of impact and adaptation of the World Bank were used for the exploitation of results. Data analyses with the Lamb index and the test of Pettitt show that the temperature tends to increase by an average of 0.84°C for Tmax; 0.83 for Tmin and 0.85°C for the seawater temperature as well as for the abnormality of the sea level, with an increase of 2.77 cm. The trend of rainfall is downward with a deficit of 100 mm between the periods 1951-1969 and 1971-2012 but marked by an alternation of wet years and dry years in recent decades. Perceptions from the populations on these parameter changes coincide with the above observed climate trends. The vulnerability analysis concluded to a low climate change adaptability capacity of stakeholders especially fishermen from a financial, physical, natural and human point of view. To improve their resilience, adaptation options such as the creation of marine protected areas, the construction of protection infrastructures and the regular access to climate information should be considered as of first priority. The results from this study constitute a decision support tool that can be mainstreamed into the municipal development plan of the city of St. Louis in order to strengthen the resilience of fisheries stakeholders, despite the numerous dangers relating to marine activities.

6. Comparative assessment of maize, finger millet and sorghum for household food security under increasing climatic risk

Rurinda Jairos[1,2,3], Mapfumo Paul[2,3], van Wijk T. Mark[1,4], Mtambanengwe Florence[2,3], Rufino C. Mariana[4], Chikowo Regis[2,3], Giller E. Kenneth[1]

[1]*Plant Production Systems, Wageningen University, P.O. Box 430, 6700AK Wageningen, The Netherlands*

[2]*Department of Soil Science and Agricultural Engineering, University of Zimbabwe, P.O. Box MP167, Mount Pleasant, Harare, Zimbabwe*

[3]*Soil Fertility Consortium for Southern Africa (SOFECSA), CIMMYT, Southern Africa, P.O. Box MP 163, Mount Pleasant, Harare, Zimbabwe*

[4]*International Livestock Research Institute (ILRI), Box 30709, Nairobi 00100, Kenya*

Questions as to which crop to grow, where, when and with what management, will be increasingly challenging for farmers in the face of a changing climate. The objective of this study was to evaluate emergence, yield and financial benefits of maize, finger millet and sorghum, planted at different dates and managed with variable soil nutrient inputs in order to develop adaptation options for stabilizing food production for smallholder households in the face of a changing climate. Field experiments with maize, finger millet and sorghum were conducted in farmers' fields in Makoni and Hwedza districts in eastern Zimbabwe for three seasons: 2009/10, 2010/11 and 2011/12. Three fertilization rates: high rate (90 kg N ha^{-1}, 26 kg P ha^{-1}, 7 t ha^{-1} manure), low rate (35 kg N ha^{-1}, 14 kg P ha^{-1}, 3 t ha^{-1} manure) and a control (zero fertilization); and three plantings dates: early, normal and late, were compared. Crop emergence for the unfertilized finger millet and sorghum were < 15% compared with > 70% for the fertilised treatments. In contrast, the emergence for maize was > 80% regardless of the fertilization rate. Maize yielded more than finger millet and sorghum, also in the season (2010/11) which had poor rainfall distribution. In the poorer 2010/11 season, early planted maize yielded 2.4 t ha^{-1}, against 1.6 t ha^{-1} for finger millet and 0.4 t ha^{-1} for sorghum in Makoni. Similar yield trends were observed on the nutrient-depleted soils in Hwedza. Crops planted early or during the normal planting window gave comparable yields that were greater than yields of late-planted crops. Marginal rates of return for maize production were greater for the high fertilization rate (> 50%) than for the low rate (< 50%). However, the financial returns for finger millet were more attractive for the low fertilization rate (> 100%) than for the high rate (< 100%). Although maize yield was greater compared with finger millet, the latter had a higher content of calcium and iron, and can be stored for up to five years. The superiority of maize, in terms of yields, over finger millet and sorghum, suggests that the suggestion to substitute maize with small grains is not a robust option for adaptation to increased temperatures and more frequent droughts likely to be experienced in southern Africa.

7. Choice and risks of management strategies of farming calendar: application to corn production in Southern Benin

Alle C. S. Ulrich[1], Baron Christian[2], Guibert Hervé[2], Agbossou K. Euloge[1], Afouda A. Abel[1]

[1]*Université d'Abomey - Calavi, Republic of Benin*

[2]*CIRAD, France*

This study examines the different levels of risks related to management choices of corn farming calendar in southern Benin. For this purpose, a series of simulations of potential yields of corn variety DMR-ESR-W has been carried out with the model SARRA-H V3.2 with a 10 day shift, from February to November, in the automatic search of the sowing date between 1971 and 2010. Thus, it has been possible to highlight the seasonal dynamics of the percentage of successful sowing, the potential yield and the grain drying date depending on the sowing date. It appears that the maxima of percentage of successful sowing and potential yield are obtained by sowing when the rainy seasons start. However, by integrating biotic constraints in the choice of the planting period, it appears that the periods of least risk to plant are the first half of May for the long rainy season and the first half of September for the short rainy season. Nevertheless, between the rains' start dates (early April) and seedlings (early May) for the long rainy season, there is a lag of about a month, which raises the question of the relevance of the adoption of the 90-days-corn varieties during the long rainy seasons as an adaptation measure.

8. Land cover changes along tropical highland agroforestry systems: call for an improved climate adaptation

Matokeo Arbogast[1], Lyimo James[1], Lelong Camille[2], Majule Amos[1], Masao Catherine[1], Mathé Pierre-Etienne[3], Vaast Philippe[4], Williamson David[4,5]

[1]*Institute of Resource Assessment, University of Dar es Salaam, P.o.Box 35 097 Dar es Salaam, Tanzania*

[2]*Cirad-TETIS, Maison de la Télédétection, 34093 Montpellier Cedex 5, France*

[3]*CEREGE, Aix-Marseille Université, BP 80, 13 545 Aix-en-Provence cedex 04, France*

[4]*CRAF, p.o. box 30 677-00100 Nairobi, Kenya*

[5]*Eco&Sols, Montpellier SupAgro-Cirad-INRA-IRD, 34060 Montpellier cedex 2, France*

[6]*LOCEAN, Université Pierre et Marie Curie-IRD-CNRS-MNHN, Centre IRD France Nord, 93 143 Bondy cedex, France*

Tropical highland ecosystem resources strongly depend on climate variability and associated water availability. This work aimed at better understanding the interactions between agro-forestry systems (cocoa and coffee) and livelihoods resulting in Land Use/Cover Changes (LUCCs) along the Rungwe tropical highlands in southern Tanzania. GIS- based analysis and remote sensing methods (World view II, Landsat Thematic Mapper and Enhanced Thematic Mapper+) were undertaken to detect and map changes among four main agro-ecosystems, namely food, cash crops, forest and irrigated agro-ecosystems. Image analysis validated with geo-coding surveys evidenced significant LUCCs since 1993 along with a ca. 3% area-per-decade increase in cocoa, a ca. 6% area-per-decade decrease in coffee, and a ca. 4 % area-per-decade decrease in natural forest cover. The latter was associated with a loss of natural species such as the fire and drought-resistant miombo trees, a critical issue under currently drier conditions. In addition, primary data collection, household questionnaire surveys and key informant interviews showed that market-driven factors of LUCCs were straightforward, as illustrated by the replacement of major agro-forestry systems and/or the emergence of valuable cash crops (*e.g.* potato) through time. LUCCs mainly impacted crops and vegetation diversity, also resulting in increased land fragmentation. In the absence of climate-smart resource management, the land cover competition between food and cash crops was stressed as a critical threat over livelihood security. Trends in cocoa, tea and new avocado agro-forestry systems developed at the expense of coffee must be further understood as a balance between climate trends, population growth, political influences and infrastructure development.

Contribution of the SAFSE project of AIRD and the Climate–Land-Agroecosystem in East Africa (CLAREA) international team.

9. Ecological intensification for a climate smart agriculture: applications from Senegal and Burkina Faso

Masse Dominique[1], Ndour-Badiane Ndèye Yacine[2], Hien Edmond[3], Akpo Léonard-Elie[4], Diatta Sekouna[4], Bilgo Ablassé[5], Hien Victor[5], Diédhiou Ibrahima[6], Ndiaye-Cissé Mame Farma[2], Tall Diouf Laure[2], Ndienor Moussa[2], Founoune Mboup Hassna[3], Feder Frédéric[7], Médoc Jean-Michel[7], Lardy Lydie[1], Assigbetsé Komi[1], Cournac Laurent[1]

[1]*LMI IESOL, UMR Eco&Sols, Institut de Recherche pour le Développement, BP 1386 Centre ISRA IRD Bel Air, Dakar, Senegal*

[2]*LMI IESOL, LNRPV, Institut Sénégalais de Recherche Agricole, Centre ISRA IRD Bel Air, Dakar, Senegal*

[3]*LMI IESOL, UFR SVT, Université de Ouagadougou, Ouagadougou, Burkina Faso*

[4]*LMI IESOL, Département de Biologie Végétale, Université Cheikh Anta Diop, Dakar, Senegal*

[5]*LMI IESOL, Département GRN/SP, Institut Nationale de l'Environnement et de la Recherche Agricole. Ouagadougou, Burkina Faso*

[6]*LMI IESOL, Ecole Nationale des Sciences Agronomiques, Université de Thiès, Thiès, Senegal*

[7]*LMI IESOL, UPR Recyclage et risques, CIRAD, Dakar, Senegal*

In the context of environmental and socio-economic changes, sub-Saharan African countries will have to ensure their food security, while reducing its environmental footprint. It is assumed that to take up the challenge of climate smart agriculture, it is necessary to intensify ecological processes of agrosocioecosystems at the scales of the soil-plant system, the farmers' fields and the agro-ecosystems and also the territories. This ecological engineering approach is the framework of the researches led by the IESOL International Joint Laboratory "Intensification of agricultural soils in West Africa". For instance, studies concerning the management of organic matters and the nutrients cycles in peri-urban agriculture and in Pearl Millet cropping systems will be exposed. We tested intensification practices as crop livestock integration, urban waste recycling, more efficient fertilizer use, and degraded lands restoring in Senegal and Burkina Faso. This will lead us to propose some rules of thumb of future innovations in semi-arid agrosystems based on the recycling and the conservation of organic matter and nutrients.

10. Incorporating climate change into agricultural research and advisory services in Africa

Lamboll Richard[1], Morton John[1], Kisauzi Dan[2], Ohiomoba Ifidon[3], Demby Dady[3], Mangheni Margaret[4], Moumouni Ismail[5], Parkinson Verona[6], Suale David[7], Nelson Valerie[1], Quan Julian[1]

[1]*Natural resources Institute, University of Greenwich, ME4 4TB, United Kingdom*

[2]*African Forum for Agricultural Advisory Services (AFAAS), P.O. Box 34624, Kampala, Uganda*

[3]*The Forum for Agricultural Research in Africa (FARA), 12 Anmeda Street, Roman Ridge, Accra, Ghana*

[4]*Agricultural Extension/ Education Department, Makerere University, P.O. Box, 7062, Kampala, Uganda*

[5]*University of Parakou, BP 123, Parakou, Benin*

[6]*AGEMA Consultancy Services, C.P 437, Quelimane, Mozambique*

[7]*Independent consultant and AFAAS Sierra Leone, P O Box 7, Freetown, Sierra Leone*

It is now clear that African agriculture needs to adapt to climate change and climate variability, but also faces opportunities to contribute to climate change mitigation and low-carbon growth. At the same time, agriculture is expected, by governments and now once more by development donors, both to provide food security, and to act as an "engine of growth". In meeting these demands, African agricultural research and advisory services will be required to improve farmers' and other stakeholders' access to agricultural technologies. How can these services now respond given significant existing capacity challenges?

This presentation will report on findings of the project "Climate Learning for African Agriculture", and in particular case studies from Benin, Uganda, Mozambique and Sierra Leone. These studies have shown the current disjuncture throughout much of Africa between climate policies on the one hand, and agricultural policies, and in particular policies for agricultural research and extension on the other. There is a further disjuncture between the regular government research and extension services, and time-limited, usually localized projects, funded by aid donors and NGOs. Projects in all four countries, whether designed explicitly to strengthen adaptation to climate change or more broadly to cope with climate variability, present good practice and possibilities for learning. However, the level of farmer participation in innovation and learning, and thus the chances for farmers to strengthen their own adaptive capacity, is in many cases more superficial than implied by project documents. The need to consider an innovation systems approach with attention to value chains, processing, marketing and input supply, rather than a simple focus on new production technologies, is not broadly recognised. Opportunities for extension services to facilitate links between farmers and climate finance schemes are not being seized. Additionally, co-ordination between projects and between projects and mainstream services remains weak, and potentially useful new possibilities for knowledge management have not been taken up. In the light of these findings, we make some practical and policy recommendations for strengthening agricultural innovation systems at project, local and national level, to increase their contribution to building farmers' resilience.

11. Developing community-based climate smart agriculture through participatory action research in West Africa: lesson learnt

Akponikpe P.B. Irenikatche[1], Bayala Jules[2], Zougmore Robert[3]

[1]*Université de Parakou (UP), Faculté d'Agronomie (FA), Unit of Environmental Soil Physics and Hydraulics (ESPH), 03 BP 351 Université, Parakou, Bénin*

[2]*World Agroforestry Centre, West Africa and Central Regional Office - Sahel Node, BP E5118, Bamako, Mali*

[3]*CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), ICRISAT Bamako, BP 320 Bamako, Mali*

This paper seeks the main outcomes and lessons learnt from the regional project on "Developing community-based climate smart agriculture through participatory action research in five benchmark sites in West Africa (1st Phase)". The project was led by the World Agroforestry Centre (ICRAF) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) under the CCAFS (Climate Change, Agriculture and Food Security). The main objectives was to test and validate, in partnership with rural communities and other stakeholders, a scalable climate-smart model for agricultural development that integrates a range of innovative agricultural risk management strategies. The program was implemented in five sites located in Burkina Faso, Ghana, Mali, Niger and Senegal. The work made use of group and individual discussions with farmers in the communities and resources persons from the partner's organizations and fields visits at benchmark sites. We found that the program fit very well with local needs especially national research/development goals (national food security programs PRSAs, National Adaptation Programmes of Action NAPAs, etc.) and had also built on past and ongoing national initiatives regarding food security and climate adaptation (capitalizing on past successes). But the implementation time was too short (2 Years) to have immediate impact on climate change constraints, which are rather long-term issues. Adaptation to CC requires longer-term investment. The most successful climate smart agriculture (CSA) activities in the project were those that were individual, well and timely planned with farmers, low cost and grounded in local values and practices. Although farmers were well aware of global environmental degradation and committed to adapt, there is still a pressing need in the region to improve their capacity regarding meteorological, climate and climate change knowledge.

12. Indigenous Climate Smart Agriculture (iCSA); local knowledge pool from urban vegetable farmers

Kweku Oduro Koranteng

Dept. of Public Admin and Health Services, Uni of Ghana Business Sch., Ghana

The focus of Climate Smart Agriculture has always been viewed by farmers as a foreign concept, hence the integration of this CSA is often overlooked. This research studied over 250 migrant urban vegetable farmers in a suburb of Accra-Dzorwulu. The study compiled a database of indigenous practices from farmers across ten regions and explored how to align indigenous farming practices to CSA in a balanced way to gain legitimacy among vegetable growers. From the finding, it was observed that farmers transformed city land spaces into arable vegetable farms. Urban land spaces are scarce and even if available are beyond the means of the average vegetable farmers. A stretch of lands under the city's high tension lines, have become the source of livelihood for over 250 urban vegetable farmers in the city of Accra. The often semi-arid land with high salinity contents is treated with indigenous soil smart practices for the cultivation of these vegetables. The irrigation dug-out used on these farms have significantly reduced the incidence of flooding especially in the low lying areas of the suburb. The farming activities protect the land from being used as a dumping site by city dwellers. Apart from the direct benefit of selling farm outputs, it also provides a source of food supply to restaurants, hotels, food vendors and homes. It is worth noting that it also cuts transportation emission associated with the transportation of food crops and provides and annual average income of about 1.5 million USD to farmers.

13. Mitigation of climate change through soil organic carbon sequestration in smallholder farming systems of Zimbabwe

Mujuru Lizzie[1], Mureva Admore[1], Velthorst Eef, J.[2], Hoosbeek Marcel R.[2]

[1]*Bindura University of Science Education, Dept. of Environmental Science, P. bag 1020, Bindura, Zimbabwe*

[2]*Wageningen University, Dept. of Environmental Sciences, Earth System Science, P.O. Box 47, 6700 AA Wageningen, The Netherlands*

Climate change mitigation through land management practices that convert atmospheric carbon (C) into soil organic carbon (SOC) has been proposed. A study was done to investigate impacts of tillage on SOC storage in sandy and clayey soils of Zimbabwe. Soil samples were collected at 0-10 and 10-30cm depths under no tillage, minimum tillage and conventional tillage. There were no significant differences in SOC stocks among tillage systems in clayey soils. On clayey soils, C storage was higher in minimum tillage (32 $Mgha^{-1}$) than no tillage and conventional tillage which had similar C stocks (31 $Mgha^{-1}$) at 0-30cm. Sandy soils however, showed more C under no tillage (11 Mha^{-1}) than minimum tillage (10 $Mgha^{-1}$) and conventional tillage (8 $Mgha^{-1}$). There was relative SOC gain under conventional tillage at 0–10cm when compared to reduced tillage and no tillage practices on clayey soils whereas on sandy soils no tillage had better C storage than conservation tillage practices. Lack of significantly different C gains under conservation tillage practices could be attributed to limited residue cover which makes soils more vulnerable to agents such as wind erosion than conventionally ploughed soils, where transitory roughness created by tillage can reduce wind and water erosion. Furthermore, long dry period coupled with free range grazing affect capacity of soil to store more C. When conventional tillage is the only available option, application of nitrogen fertiliser is more beneficial for increasing C stocks in sandy soils whereas application of organic fertiliser (cattle manure) has greater C benefits in clayey soils. Increased SOC improves crop production, thus ensuring climate change mitigation and food security. Residue retention strategies need to be developed to improve environmental and productive capacity of cropping systems in smallholder farming systems in arid and semi-arid areas where communal grazing rights are common.

14. Climate-smart intensification of West-Africa's cocoa systems

van Asten Piet[1], Jassogne Laurence[1], Vaast Philippe[2] Laderach Peter[3], Schroth Götz[4], Lundy Mark[3], Asare Richard[5], Muilerman Sander[5], Ruf R.[6], Snoeck Didier[6], Koko Louis[7], Anim-Kwapong Gilbert[8], Rossing Walter[9], Gockwoski James[5], Giller Ken[9], Six Johan[10], Vanlauwe Bernard[11]

[1]*IITA, Kampala, Uganda*
[2]*ICRAF, Nairobi, Kenya*
[3]*CIAT, Cali, Colombia*
[4]*Rainforest Alliance, Wageningen, the Netherlands*
[5]*IITA, Accra, Ghana*
[6]*CIRAD, Montpellier, France*
[7]*CNRA, Abidjan, Cote d'Ivoire*
[8]*CRIG, Kumasi, Ghana*
[9]*WUR, Wageningen, the Netherlands*
[10]*ETH, Zurich, Switzerland*
[11]*IITA, Nairobi, Kenya*

Global demand for cocoa is increasing by 2-3% annually, particularly due to growth in Asia. About 70% of global supply originates from West-Africa where cocoa is produced by smallholder farmers (<5 ha). Their yields are low (10-30% of potential) and highly variable with limited use of external nutrient inputs. Over the past decades, cocoa supply relied largely on the expansion of the crop into 'fresh' forest. Consequently, cocoa has been a key driver of deforestation. With less than 15% of the original cover in West Africa remaining, the cocoa industry is increasingly concerned about its future supply, particularly now that recent studies revealed that climate change further threatens the current production zones. Climate-smart intensification is required to ensure both smallholder livelihoods and the industry's need.
Over the past decades, many of the cocoa actors have promoted full-sun intensified systems. Whereas these systems have the highest production potential, they do expose farmers to risks of climate variability and reduced sustainability. Fertilizer use is currently limited to areas where fallow land is no longer available and/or where government programs (read subsidies) enhance access to external nutrient inputs.
There is an urgent need for (i) technical recommendations on how to achieve intensified climate-smart cocoa systems and (ii) improved channels of communicating this knowledge to the smallholders.
In this presentation, we give an update on where the key research actors are with respect to climate-smart intensification technologies and approaches. The challenge faced may require enhanced networks and novel platforms in a sector that is traditionally characterized by a high degree of fragmentation.

15. Effect of oil and addition of enzymes on fibre digestion, methane production and performance of sheep

Booyse Maruzaan, Hassen Abubeker

Department of Animal and Wildlife Sciences, University of Pretoria, Pretoria 0002, South Africa

The red meat industry in South Africa is important, but globally there is a big interest in greenhouse gas emissions and reducing our carbon footprint. Supplementation of oil in ruminant diets is one method of decreasing methane production. The potential benefits of supplementing ruminants with palm oil have not been studied in detail in terms of effects on methane production, rumen fermentation parameters, digestibility and performance. Enzymes are often added to ruminant feed to increase the digestibility of the diet, but associated with this is an increase in methane production due to an increase in hydrogen ions. This increase in hydrogen concentration can possibly be compensated for by adding oil to the diet, as the double bonds in oil may serve as a hydrogen sink due to rumen hydrogenation. In this in vitro study a total mixed ration (TMR) was treated with one of six treatments. Two oils were tested and compared, namely palm oil and canola oil added at a level of 3% of the TMR. The enzymes used were a 1:1 ratio of xylanase and cellulase added at 1ml/kg TMR. The first was a control with only TMR, the second was TMR with canola oil, third TMR with palm oil, the fourth treatment was TMR with enzyme addition, treatment 5 was TMR, enzyme and canola oil and lastly treatment 6 was TMR, enzyme and palm oil. Canola oil reduced methane by 2.08% compared to the control, while canola oil and enzyme decreased methane emissions by 18.76%. Palm oil decreased methane by 25.48%, while palm oil and enzyme decreased methane emissions by 29.66% compared to the control diet. This study shows that oils can be used to decrease methane emissions and there is potential for oil together with enzyme supplementation to further decrease methane emissions. Currently the study is being performed in vivo on 40 sheep in a 60 day growth trial. Methane emissions of the treatments are measured in a respiratory chamber. The study will include animal performance parameters and feed parameters.

16. Drought and adaptation strategies of rural maize-legume farmers in Kenya and Tanzania

Muricho Geoffrey[1], Tongruksawattana Songporne[1], Mutheu Judith[2]

[1]*International Maize and Wheat Improvement Center (CIMMYT), Nairobi, Kenya*

[2]*African Economic Research Consortium, Nairobi, Kenya*

Poverty and dependence on rain-fed agriculture in Sub-Saharan Africa has rendered the countries in this region vulnerable to unexpected deviation in rainfall amounts and distributions. Between 2000 and 2010, drought has become the most common and disruptive climate-related shock on smallholder's farm production in Kenya and Tanzania which has led to substantial loss in food crop production and household income. Employing a multinomial logit model, this study analyzes the determinants of adoption of various combinations of adaptation strategies to drought and assesses how smallholder farmers in maize-legume cropping systems respond to drought in both countries. Kenyan farmers applied a single strategy or a combination of two to three strategies probably due to less frequent and less severe drought occurrences in Kenya, while Tanzanian farmers diversified more and combined at least two to five strategies. In both countries, farmers use common on-farm adaptation strategies including drought tolerant crops/varieties and replanting, as well as off-farm adaptation strategies of selling assets and reduced consumption. Tanzanian farmers were also found to diversify crops and borrow as additional strategies, respectively. In both countries, the multinomial logit results show that farmers' choice of different combinations of drought adaptation strategies is mostly driven by household, institutional, rainfall variation, temperature and drought shock effect factors. Rainfall variation and temperature fluctuation were found to determine farmers' decision on all adaptation strategy combinations in both countries while additional effects of crop pests support on-farm strategy combinations in Kenya. Agricultural development policy should prioritize breeding and agronomy research to innovate and advance new varieties and agronomic practices that increase the productivity capacity and resilience of farmers under water and heat stress conditions. Furthermore, policy to support small-scale adaptation should provide enabling an environment for farmers to take the initiatives of complementing on-farm and off-farm adaptation strategies.

17. Biochar as an opportunity for climate-smart agriculture in small-holder farming systems in Kenya

Sundberg Cecilia[1], Karltun Erik[1], Mahmoud Yahia[2], Nyberg Gert[1], Njenga Mary[3], Roobroeck Dries[4], Röing de Nowina Kristina[4]

[1]*Swedish University of Agricultural Sciences 750 07 Uppsala Sweden*

[2]*Lund University, Sweden*

[3]*World Agroforestry Centre, ICRAF, UN Avenue, Nairobi, Kenya*

[4]*International Institute of Trobical Agriculture (IITA) Nairobi, Kenya*

Biochar, or black carbon formed by heating biomass under oxygen-limited-conditions, can be used as a soil amendment to improve soil productivity and sequester carbon in the soil. However, to understand the potential of biochar to contribute to reductions in greenhouse gas emissions, the alternative fate of biomass used for biochar production must be considered. Biochar-producing cook stoves can have additional beneficial effects on greenhouse gas emission reductions and health by reducing fuel demand and reducing smoke. In a research project in Kenya, biochar production and use are investigated in small-holder farming systems. The effects of biochar on local soils is tested in pot and field trials. Experiments focus on combined effects of biochar, lime and mineral fertilizer. Different application rates of biochar produced from three feedstocks (coconut husk, maize and coffee husks) are compared. Moreover, the energy efficiency and GHG emission reduction potential from biochar producing cook stoves are tested in participatory field trials. Preliminary results from the pot trials show increased yields in treatments where biochar was applied, although the effect varied with soil type. The cook stove tests show significant reductions of fuel required to cook a standard meal, as well as reduced PM and CO emissions, in addition to well-functioning biochar production. In conclusion, biochar is seen as a very viable option in providing smallholder farmers with win-win-win situation in their quest to improve soil productivity and crop yields, energy efficiency and health.

18. Farmers' perceptions of rainfall and agronomic trends in Allada plateau in southern Benin

Alle Cayossi S. Ulrich[1], Guibert Hervé[2], Baron Christian[2], Agbossou Euloge K.[1], Afouda Abel A.[1]

[1]*Université d'Abomey Calavi, Bénin*

[2]*CIRAD, France*

Although several studies show an increase in agricultural production in West Africa in connection with the improvement in rainfall, farmers perceive otherwise. This study highlights the differences between farmers' perceptions of changes in precipitation and their impacts on agricultural production and scientific observations in the Guinea region where two rainy seasons coexist. For this purpose, it compared precipitation data (from 1951 to 2010) and potential yields of corn (from 1970 to 2010), simulated by SARRA-H model, to farmers' perceptions of changes in precipitation collected from 201 farm managers spread over 67 villages in Southern Benin. The study clearly shows that farmers do not make any distinctions between the long rainy season and short rainy season in terms of changes in rainfall and agronomic impacts. On the contrary, climate analysis results, and agronomic simulations reveal that the long rainy season and short one are not affected in the same way by atmospheric forcing. Consequently, these two rainy seasons have opposite agronomic trends. Since 1970, the long rainy season has a rainfall deficit coupled with a poor temporal distribution of rainfall and a shortening in its duration which led to a sharp drop in potential crop yields. Conversely, since the late 1980s, the short rainy season rainfall recorded a surge which causes a sharp increase in agricultural yields. This pessimistic perceptions of farmers on the evolution of rainfall in both rainy seasons influences their choice of management of the farming calendar of the short rainy season, worsening food insecurity in the study area.

19. Climate and maize storage losses from insect pests in East and Southern Africa

De Groote Hugo, Gitonga Zachary, Sonder Kai, Mugo Stephen, Tefera Tadele

CIMMYT, PO Box 1041-00621 Nairobi, Kenya

Maize is the main food staple and source of livelihood to most rural families in eastern and southern Africa. Its production is also seasonal but consumption is stable throughout the year. Storage insect pests are a major source of grain losses, and are more active in warmer and more humid climate. Hermetic containers, metal silos or bags, offer good potential for climate-smart storage technologies. However, the exact relationship between losses caused by the insects and the climate, is not known. Household surveys were conducted to collect representative, georeferenced data using multistage sampling procedures from main maize agro-ecologies in Zambia, including maize production, storage methods, farmer perception of the importance of storage insect pests, and an estimation of the losses caused. Climate data from secondary sources were in a nonlinear logistic regression model to estimate the relationship between climate indicators and extent of storage losses. Maize weevil was perceived as the most important maize storage pest, followed by the larger grain borer (LGB). Farmers estimated storage pests to have caused losses averaging 12%. A strong positive relationship was found between loss (L, in %) with average temperature (T, in °C) and relative humidity (RH, in %) was found: L= 1/(1 + Exp(7.052 - 0.0929 Temp - 0.06782*RH). This relationship was used to map expected storage loss in the major maize growing countries of East and Southern Africa, and overlay it with maize production to identify the hotspots and the regions with major maize losses due to storage pests. Because losses increase with both temperature and humidity, which are inversely related, hotspots are found where temperatures are high but conditions are not too dry. Expected changes in temperature were used to predict the increased expected losses, and results indicate the high potential of hermetic storage as climate-smart storage technologies.

20. Maize-based farm household typology and vulnerability to climate shocks in Kenya

Tongruksawattana Songporne[1], Lopez-Ridaura Santiago[2], Tesfaye Kindie[3], Frelat Romain[2], Gitonga Zachary[1]

[1]*International Maize and Wheat Improvement Center (CIMMYT), Nairobi, Kenya*

[2]*International Maize and Wheat Improvement Center (CIMMYT), El Batan, Mexico*

[3]*International Maize and Wheat Improvement Center (CIMMYT), Addis Ababa, Ethiopia*

Maize is the most important food crop in Kenya, but its production is challenged by successive crop failures due to increasing climate variability and recurrent climate shocks. Adapting maize to increasing climate variability and change requires understanding the diversity of farming systems and farm households beyond agro-ecological zoning. A study was conducted on 1,344 representative households in the major maize production zones of Kenya to identify groups of farm households with similar household and farming system characteristics using a farm typology approach. The study gathered information on the frequency of experience of each household to weather shocks (exposure) and proportion of such experience that the households felt was a shock (sensitivity) in the past 10 years. Based on qualitative participatory insights from farm community focus group discussion, distinctive exogenous variables were used to identify farm household typology by means of Non-Linear Principal Component Analysis and hierarchical Cluster Analysis. Four farm typologies were identified: 1) large-scale, food secure, wealthy, commercialized farmers in average altitude in the West; 2) small-scale, food secure intensive cash-crop and commercial livestock farmers in high altitude in the West, Central and East; 3) small-scale, severe food insecure, poor, food-crop and traditional livestock farmers in flat land at the coast, in the West and East; 4) medium-scale and food insecure maize-legume intercropping farmers in flat land in the West and East. Farm typologies 3 and 4 show highest exposure and sensitivity to drought, whereas farm typology 2 is most vulnerable to excessive rainfall and cold. These findings provide initial insights into household diversities and their importance for policy considerations and targeting climate-smart agricultural technologies. In addition, characteristics of farm households in each farm typology can assist policy and development agencies to design appropriate vulnerability reduction measures to relevant climate shocks.

21. Changing crop practices to address climate related risks among rural farmers in Nyando, western Kenya

Recha John, Kinyangi James, Radeny Maren

CGIAR Research Program on Climate Change, Agriculture and Food Security, East Africa Region, International Livestock Research Institute, P. O. Box 30709 - 00100 Nairobi, Kenya

Smallholder farmers in Nyando, western Kenya are working closely through community based organizations (CBOs) to champion crop practices that will transform the ability of their communities to withstand increasing heat and drought resulting from variable seasonal rainfall. Participatory action research that uses new and improved crop varieties from the Consultative Group on International Agricultural Research has been ongoing for three years. A total of 250 farmers are involved in the trials of improved maize, sorghum, bean and cowpea varieties, and new green gram crops. With the use of improved agronomic practices, the improved maize yields five times higher, while sorghum yields four times more compared to the baseline. The improved bean and cowpea varieties yield six times more compared to the baseline. The allocation of land by households to different crop enterprises has changed in the three year period. The legumes currently occupy 10% of the land compared to 5% at the baseline. While cereals still take up the biggest portion of the land, there has been a threefold increase in acreage allocated to sorghum from less than 10% to the current 33%. The land allocation for maize has decreased from 75% to 44%. Through the CBOs that constitute 70% active women members, the farmers have pooled together resources, ensuring better bargaining power and sharing of emerging lessons. The CBOs have an Innovation Fund that provides loans used for agricultural investments totaling to US$ 30,000 in the three year period. As a result of the community agricultural innovations, there is an increase in the number of food secure households during the March–August season from 10% to 40%. There is a potential of scaling up the innovative ideas through a participatory process to help farmers access improved agricultural technologies and knowledge for enhanced food security.

22. Establishing an operational dialogue between researchers and decision-makers for adaptation to climatic changes in Mali

Sogoba Bougouna[1], Ba Allassane[2], Zougmore Robert[3], Samake Oumar B.[4]

[1]*ONG AMEDD, BP: 212, Koutiala, Mali*

[2]*Conseiller spécial du premier ministre du Mali ; BP: 2357, Bamako, Mali*

[3]*ICRISAT, BP:320 Bamako, Mali*

[4]*ONG AMEDD, BP:212, Koutiala, Mali*

In Mali, the climate is a tropical, semiarid one. It is a country where the climatic variability and changes constitute a serious threat to the food security of Malian populations, especially for those whose means of subsistence depend on small-scale agriculture. So as to develop practical solutions to agriculture problems, it henceforth necessitates in an innovative and comprehensible manner the taking into account of knowledge on climatic changes, agriculture and food security. In doing so, climatic questions should be incorporated in national policies and strategies for beneficial actions which will enable the resilience of rural populations in Mali. The investigation carried out within the framework of the activities of the national platform of dialogue and science-politics on climatic changes, agriculture and food security, enlightens the different stakeholders on the situation of the country's institutions, challenges, constraints and opportunities for an operational dialogue between researchers and decision-makers for an adaptation to climate change. Eight key messages have been taken from the investigation and they are based on: (1) the situation of the existing institutions for a functional dialogue; (2) the difficulties of organization and operation of the institutions engaged in the struggle against climatic changes; (3) the need for a reinforced partnership between institutions; (4) the necessity for an adequate financial support; (5) the situation of dialogue between researchers and decision-makers in Mali; (6) the constraints for an operational dialogue between researchers and decision-makers in Mali; (7) the opportunities for an operational dialogue between researchers and decision-makers; (8) the need for a space of communication between researchers and decision-makers in Mali. The consideration and analysis of these messages will eventually lead to actionable recommendations for an improvement of inter-institutional dialogue and the making of appropriate decisions. The political decisions that would be taken out all the foregoing will contribute to the promotion of a smart agriculture for the improvement of the resilience of farms in Mali.

The process is conducted by the national platform of dialogue science-politics on climate change, agriculture and food security (C-CASA Mali) with the technical and financial support of the Program CCAFS – West Africa)

23. Women involvement in agricultural water management: example from supplemental irrigation in the Burkinabe Sahel

Bologo/Traoré Maïmouna[1], Fossi Sévère[2], Zougouri Sita[3], Bado Eulalie[1,3]

[1]*International Institute for Water and Environmental Engineering (2iE), Department of Managerial Sciences, 00226, Ouagadougou, Burkina Faso*

[2]*International Institute for Water and Environmental Engineering (2iE), Department of Hydraulics and Sanitation, 00226, Ouagadougou, Burkina Faso*

[3]*University of Ouagadougou, Department of Sociology, 00226, Ouagadougou, Burkina Faso*

The Supplemental Irrigation and Climate Information project (IDRC project) aims to help population find adaptation strategies in a climate change context, by constructing runoff harvesting basins for supplemental irrigation in the north-central and the northern Burkina Faso. In this project, women occupy a prominent place, since they are deeply involved in agricultural activities and are often the first victims of drought, with consequences like malnutrition and starvation. This paper proposes to highlight the causes of these obstacles and implementation strategies to circumvent them, through examples from nine villages in two provinces located in the Burkinabe Sahel. Data were collected in the provinces of Bam and Yatenga. We conducted interviews with country men and country women, traditional and religious authorities, agents from technical branches of agriculture and NGO leaders. In each area, we interviewed members of the pilot farms and we organized focus groups with men and women of rural communities. For focus groups, we did not mix men and women. In the province of Yatenga, three women were chosen as recipients for runoff harvesting basins. In Yatenga, men have understood that if women have runoff harvesting, it is profitable for household. Unfortunately, in the province of Bam, no woman was chosen. Things being what they are, women represent a significant workforce during the construction of basins. They prepare the meal and transport the excavated soil. They also bring water both for drinking and fitting out the basins. We noticed that housework like washing, washing-up and cooking are done with water from runoff harvesting basins in some villages: Sandouré, Sorgho-Yarcé and Koumbri. One of the challenges of research will be to offer strong and inexpensive runoff harvesting basins, but also to find mechanisms to improve women's involvement, without weakening the social fabric of village communities.

24. Assessing potential climate change impacts in smallholder systems in Burkina Faso

Medina Hidalgo Daniela[1], Herrero Mario[1], De Voil P.[3], Douxchamps Sabine[4], Thornton Phillip[6], Van Wijk Mark[5], Rodriguez Daniel[3], Prestwidge Di[1], Henderson B.[1], Rigolot Cyrille[1,2]

[1]*Commonwealth Scientific and Industrial Research Organization, St Lucia, QLD 4067, Australia*

[2]*INRA, UMR 1273 Metafort, F-63122 Saint Genes Champanelle, France*

[3]*University of Queensland, Queensland Alliance for Agriculture and Food Innovation (QAAFI), Toowoomba, Australia*

[4]*International Livestock Research Institute (ILRI), Ouagadougou, Burkina Faso*

[5]*International Livestock Research Institute (ILRI), PO Box 30709-00100, Nairobi, Kenya*

[6]*CGIAR Research Programme on Climate Change, Agriculture and Food Security, (CCAFS), PO Box 30709-00100, Nairobi, Kenya*

Understanding how climate change might impact agricultural systems at a household level is crucial in the development of adaptation strategies. In this study we assessed the sensitivity of four different types of smallholder mixed crop-livestock systems in Burkina Faso, to the potential impacts of climate change, based on the changes in household income and kilocalorie production. The four systems with different levels of resource endowment were simulated over 99 years using a whole farm model (APSFarm-LivSim), under current and future climate. The climate data for current climate variability and the climate change scenario were generated using the MarkSim™ tool. For future scenarios, we used the ensemble means of 17 global circulation models (CMIP5 data) for 2050, and IPCC scenario RCP 8.5. Under the projected climate scenario, average annual rainfall is expected to increase from 607mm to 674 mm (+11%). Additionally, average temperature is likely to increase by 2.6°C. Overall, these changes in climate showed to negatively affect crop yields, particularly cowpea (-25%), millet (-15%) and groundnuts (-5%); while sorghum and maize did not show significant changes in yields. At the household level, income and kilocalorie production were reduced by up to 17% and 13%, respectively, in a market-oriented household with a relatively smaller area per capita. Furthermore, we introduced two levels of fertilization in the simulation (+30 +60 Kg/N/Ha). The simulation showed that fertilizers have a positive impact on yields under current climate; however this effect decreases under the climate change scenario. For example, when adding 60 Kg/N/Ha, average maize yields increased by 145% under the current climate scenario, but only by 105% under the projected climate change scenario. This suggests that climate change might limit the potential of the farms to increase productivity.

25. Micro-level appraisal of success stories of pro-poor climate adaptation and mitigation field experiences

Bockel Louis[1], Bernoux Martial[2], Zingg Felix[1], Grewer Uwe[1], Chotte Jean-Luc[2]

[1]*Agriculture Development Economics Division (ESA) FAO Via delle Terme di Caracalla, 00153 Roma, Italy*

[2]*UMR Eco&Sols IRD, 2 Place Viala, 34060 Montpellier, France*

Targeted metrics that jointly address food security and climate change impacts are necessary to assess the performance of improved techniques at household and plot level, and inform agricultural investment planning. Policies and projects should be designed to maximize synergies between the different objectives of Climate Smart Agriculture (CSA) and to move towards a multi-benefit approach. Appraisal and capitalisation of success stories from CSA and agroecology field experiences are essential to identify options with the best potential for significant scale-up, enabling public investments to function as a leverage for rural transformation processes. International development finance – for both project and policy reform – should increasingly reward "multiple benefit" interventions. The separate targeting of various environmental and socio-economic benefits under distinct financing streams has in the past actively reduced incentives for synergetic investment planning.
Today, in addition to usual economic and financial project indicators, donors increasingly ask for performance indicators that quantify project impacts on climate resilience, GHG emission and natural capital. In line with the interest of donors and technical R&D agencies, FAO and IRD have started to test a methodology to simultaneously appraise the multiple benefits of CSA and agroecology success stories in terms of incremental income, mitigation and climate resilience at farm and plot level in Madagascar and Rwanda. The capitalisation of success stories thereby functions as an important tool to facilitate the replication and scale-up of best practices. The appraisal methodology is based on a series of household interviews with farmers and field operators to appraise the effective cost-benefit of improved practices. Surveys are designed to provide multiple-benefit performance indicators analysing simultaneously (i) the pro-poor impact (farm income), (ii) climate resilience impacts (assets and income shocks) and (iii) mitigation impacts. The presentation will provide first results and lessons learned.

26. Economic analysis of effect of flood on income distribution among farmers in Edo State, Nigeria

Osasogie Daniel Izevbuwa[1], Alabi Reuben Adeolu[2]

Department of Agricultural Economics and Extension, Ambrose Alli University, PMB 14, Ekpoma, Edo State, Nigeria

The study estimated the effect of flood on the income distribution of the victims in Etsako East Local Government Area of Edo State. A multistage sampling technique was employed to sample respondents for the study. Questionnaire and interview schedule were used to obtain information from the farmers. The data obtained were analysed econometrically. Results from analysis of data showed that the total income of the victims from all the activities before the flood was N 876480, however, they lost 79% of this to the flood. The average compensation was N 85676 while the uncompensated loss was N 577574. The study reveals further that in spite of the fact that the flood incidence reduced the income of the victims, it also worsen income inequality among the victims of the flood despite the compensation received from the government. Generally, income inequality increased by 123% among the victims after the flood. The income inequality increased among the victims due to the lopsidedness of the distribution of the compensation. For example, the study indicates that the middle income group lost 18% of their income during the flood and they got only 13% of the total compensation, whereas the richest income group lost 33% of their income and received 44% of the total compensation. Corruption and tribalism have been implicated for the skewed distribution of the compensation among the victims. This study therefore recommends the need for preventive measures to guide against future occurrence of flood among the people living close to riverine areas. In case of flood disaster, amount of compensation that is commensurable to the losses of the people is recommended. A transparent system during the registration of the losses of the victims and administration of the compensation is essential to reduce the effect of the flood incidence on depth and severity of poverty.

27. Identifying farm-level hotspots to target greenhouse gas measurements in smallholder crop-livestock systems

Ortiz Gonzalo Daniel[1], Rosenstock Todd S.[2], Vaast Philippe[3], Oelofse Myles[1], de Neergaard Andreas[1], Albrecht Alain[3]

[1]*University of Copenhagen, Department of Plant and Environmental Sciences, Thorvaldsensvej 40, 1871 Frederiksberg C, Denmark*

[2]*World Agroforestry Centre ICRAF, East & Southern Africa Regional Programme, United Nations Avenue, GigiriPO Box 30677, Nairobi, 00100, Kenya*

[3]*Affiliation of author 3 and 6. CIRAD, UMR 210 Eco&Sols - Batiment 122 Place Viala F-34060 Montpellier cedex 2, France*

In sub-Saharan Africa, data quantifying greenhouse gas (GHG) emissions and removals from smallholder's production systems are available for only a limited set of farm activities and agroecosystems. Due to this scarcity of data, IPCC Tier 1 emission factors are typically used to calculate farm emissions despite the fact that they are based on external estimates. To overcome the degree of uncertainty when using generalized emission factors for heterogeneous and multi-functional sub-Saharan smallholder crop-livestock systems, we wished to test if we could predict hotspots to guide GHG measurements. We believe that by identifying hotspots we achieve a key step in order to: 1) Guide measurements to save efforts and resources; 2) Determine the accuracy or inaccuracy of current estimations; 3) Reduce the risk of increasing errors thorough the running of models or scaling fluxes to larger spatial scales; 4) Target factors with higher contribution to the GHG balances; 5) Identify options with major potential of mitigation. We developed guidelines to identify hotspots based on systems deconstruction from what is already known about nutrient stocks and GHG fluxes. We hypothesized that we can derive hotspots and target our measurements toward the systems' nutrient pools changes. The method is tested with data from the highlands of Kenya, in Murang'a and Nyeri districts. This involved calculation of farm-level GHG balances and an assessment of the major fluxes. Then a sensitivity analysis provided the quantification of uncertainty that informs about the spatial and temporal measuring requirements to guide sampling. Finally we discussed barriers to mitigation practices based on a full system analysis that considers realistic biophysical and socioeconomic constraints.

28. Intensification test on maize production in the Sudano-Sahelian zone: techniques, soils, climate and economic conditions

Guibert Hervé[1], Olina Bassala Jean-Paul[2], Vunyingah Michael[2]

[1]*Cirad, UPR Aïda, F-34000, Montpellier, France*

[2]*Irad, Po Box 415, Garoua, Cameroon*

The global context expects increased food production in the agricultural sector thereby substituting benefits in the petroleum sector and related services *i.e.* the conservation of biodiversity or carbon sequestration. These objectives are intended to be achieved under the constraint of expected climate change. Progress is particularly hoped for African agriculture, which by its low-intensity practices and low current yields is faced with a substantial margin of progression. The study conducted in two villages (Gashiga and Kawtal) in northern Cameroon during the 2013 farming season aimed to understand the feasibility of maize intensification in the current physical, climatic and economic conditions. Gashiga experienced sporadic rainfall during the 2013 farming season contrary to better rainfall conditions at Kawtal. Two levels of intensification were compared to the peasant practices (NP) consisting of 36 plots of producers with contrasting soil fertility levels, two repetitions conducted per plot. The first level (N1) corresponds to the specifications of the crop currently disseminated. The second level (N2) comprised of more intensive techniques (variety, seed treatments, organo-mineral fertilization and fight against weeds). The test cluster analysis showed increased production for N1 and N2 against NP (respectively 0.8 and 1.9 $t.ha^{-1}$) of maize grain at Kawtal. Yields for NP and N1 were equivalent at Gashiga and N2 experienced an increase of 1.5 $t.ha^{-1}$ of maize grain Soil fertility impacted just NP. Factors such as crop density and weed pressure limited the result of intensification. Despite the increased production achieved, both levels of intensification were not profitable. More than climate, economic conditions are a major constraint for crop intensification in North Cameroon.

29. Profile of climate smart agricultural technologies in the dry Guinea savannah and forest zones in Ghana

Botchway V. A. [1], Karbo N.[1], Zougmore R.[2], Sam K. O.[1]

[1]*CSIR-Animal Research Institute, Accra, Ghana*

[2]*ICRISAT, Bamako, Mali*

World population is expected to reach 9 billion by 2050. A majority of the increase is expected to come from least and developing nations especially sub-Saharan Africa. There is a corresponding need to increase food production by 70 per cent above current levels. Business as usual cannot achieve this target. Vulnerability of agriculture and food system is most intense in countries where higher population increases are expected. The impacts of climate change are expected to further reduce productivity and lead to greater instability in the agricultural and food sectors of these vulnerable countries.

In Ghana for instance, the dry guinea savannah agroecological zone is characterized by dry deciduous to semi-arid climatic conditions, uni-modal rainfall pattern with high intensity rains, long dry season with high temperatures leading to high evapotranspiration. The soils are generally low in natural fertility (low organic matter content) and highly erodible. Currently, these characteristics are being observed in some parts of the forest zone as a result of intense mining activities and deforestation due to environmentally unfriendly human activities. Coincidentally, these two agroecological zones constitute the major food basket areas in Ghana. Sustainability of agriculture and food systems therefore require Climate Smart Agricultural (CSA) technologies and best practices or actions that will help cope with associated threats and adverse effects.

Generally, Climate Change adaptation actions appear isolated, disjointed and uncoordinated for meaningful gains in the nation. This resulted in the establishment of National Climate Change Agriculture and Food Security platforms to ensure vertical interaction and linkages between the local level community actors (who are in the majority), researchers and policy or decision makers. In line with the platform activities, a participatory multi-stakeholder mobilisation was strategically held in Upper West and Ashanti Regions to profile and rank CSA technologies and practices in the two agroecological zones according to pre-determined sets of criteria. Reasons for ranking were given, constraints and suggested actions/solutions to address these challenges at farmer level, research and extension as well as policy levels were identified. Some policy recommendations were also given.

This presentation seeks to reveal the synergies that exist among CSA technologies and best practices in these two agro-ecological zones. It also facilitates sharing and adoption of the relevant CSA technologies and practices for robust food systems and resilient production base. The experiences could pave the way for further collaborations with other initiatives that require such efforts; thereby contributing towards the Climate-Smart World.

30. Contribution to the valorisation of forest species potentialities in promoting climate smart agriculture in Madagascar

Andriampiolazana Manony[1], Randevoson Finaritra[1], Rajoelison Gabrielle[1], Cailleau Guillaume[2], Verrecchia Eric[2], Razakamanarivo Herintsitohaina[3]

[1]*Département des Eaux et Forêts, Ecole Supérieure des Sciences Agronomiques- Université d'Antananarivo, BP 175 - Tanà 101 Madagascar*

[2]*Faculté des géosciences et de l'environnement, Institut des dynamiques de la surface terrestre - Université de Lausanne, Quartier UNIL-Mouline, CH-1015 Lausanne, Switzerland*

[3]*Laboratoire des Radioisotopes - Université d'Antananarivo, Route d'Andraisoro BP 3383, Madagascar*

Some recent studies revealed that specific trees are able to produce calcium carbonate, with the help of soil microorganisms, through a process called the oxalate-carbonate pathway. Oxalate, a photosynthetic by-product, reaches the soil as litterfall. It will be then oxidized by oxalotrophic bacteria inducing a soil alkalinisation and allowing eventually carbonate to precipitate. Consequently, such trees contribute to increase soil productivity, by increasing the pH on previously acidic soils, and to mitigate climate change using a non-calcareous soil. *Tamarindus indica* (FABACEAE-CAESALPINIOÏDEAE) and *Ceiba pentandra* (BOMBACACEAE) are among alleged oxalogenic trees that can be found in Madagascar. But are they really able to contribute to a sustainable agriculture capable of dealing with climate change? The first step of this study is to check if specimens of these species from the western regions of Madagascar are oxalogenic or not. If so, is there any other potential use for these trees? Exploration results reveal that the soil content in carbon and calcium carbonate (in 0-10 cm and 10-20 cm deep layers) at the foot of those trees are positively correlated and significantly higher than at distant soil (at 5m from the tree). Soil pH around the rhizosphere is also significantly less acidic than at 5m, especially in the first 10cm. Trees from both species can be considered as oxalogenic, but specimens of *Tamarindus indica* seem to be the most promising. Regarding their potential use, they are also multipurpose trees as they can be very useful in agroforestry as well as in traditional medicine and chemical industries. *Tamarindus indica* and *Ceiba pentandra* are considered as an opportunity to face present day problems of humanity, such as food insecurity, climate change and poverty. However, more research focused on the determination of the most efficient application is still needed before promoting such initiatives in agriculture.

31. Optimizing rhizosphere microbiology and hydrology of shrub-intercropping for buffering climate change in the Sahel

Dick Richard[1], Diédhiou Ibrahima[2], Dossa Ekwe[3] , Kizito Fred[4], Chapuis-Lardya Lydie[5,6], Badiane Ndourb Yacine[7], Debenport Spencer J.[1], McSpadden Gardener Brian B.[1], Assigbetsea Komi B.[5,6], Bright Matthew[1], Schreiner Paul[8], Founoune Mboupc Hassna[7], Bayala Roger[7], Diallo Ndeye Hélène[7]

[1]*The Ohio State University, Columbus, Ohio, USA*

[2]*Université de Thiès, Thiès, Senegal*

[3]*International Fertilizer Development Corporation, Lome, Togo*

[4]*International Water Management Institute, Accra, Ghana*

[5]*Institut de Recherche pour le Développement, IRD, UMR Eco&Sols, Dakar, Senegal*

[6]*LMI IESOL Intensification Ecologique des Sols cultivés en Afrique de l'Ouest, Dakar, Senegal*

[7]*Institut Sénégalais de Recherches Agricoles, ISRA Dakar, Senegal*

[8]*United States Department of Agriculture, Agricultural Research Service, Corvallis, Oregon, USA*

The Sahel is experiencing landscape and soil degradation that reduces food and economic security of rural, underprivileged communities. The Parkland system of randomly distributed trees is an approach to address these challenges, but trees are slow growing and can compete with crops for light, water, and/or nutrients. Conversely, two native shrubs, *Piliostigma reticulatum* and *Guiera senegalensis*, coexist in farmers' fields throughout the Sahel and until recently have largely been overlooked. Unfortunately, the current management of spring coppicing and burning prior to cropping is not utilizing this organic matter effectively. Our team has done extensive field-based investigations in the Peanut Basin of Senegal that included: ground surveys and remote sensing on landscape levels of shrub C and biomass; hydrology and water relations between shrubs and crops; rhizosphere microbiology; residue decomposition; N and P cycling in relation to crops; and crop productivity. We found that optimized, non-thermal shrub-crop systems have great potential for improving crop productivity and our research argues that it would be an ecological buffer for climate change in the Sahel. The major findings in Senegal are that:

- shrubs are by far the largest source of organic matter on the landscape in cropped fields
- shrubs increase soil quality
- decomposition rates are rapid enough to allow non-thermal residue management
- shrub roots perform hydraulic lift by moving water from wet sub- to dry surface-soils that appears to drive microbial processes year around and assist crops through drought periods
- shrub roots recharge groundwater in the rainy season, reducing runoff and conserving water
- shrub rhizospheres promote microbial diversity and harbour beneficial microbes
- intercropped shrubs do not compete with crops and significantly increase crop yields, with or without fertilizer inputs, especially in the annual rainfall of <600 mm
- repeated application of these low quality residues (in absence of live shrubs) begins increasing yields after 2 years.

32. Native shrub management on soil nematofauna: optimization and adaptation to climate change of Sahelian agroecosystems

Diakhate Sidy[1,2], Mboup Hassna Founoune[2], Ndour Yacine Badiane[1,2], Chapuis-Lardy Lydie[3], Dick Richard P.[4]

[1]*Institut Sénégalais de Recherches Agricoles, ISRA-LNRPV Laboratoire National de Recherches sur les Productions Végétales, Dakar, Senegal*

[2]*LMI IESOL Intensification Ecologique des Sols cultivés en Afrique de l'Ouest, Dakar, Senegal*

[3]*Institut de Recherche pour le Développement, IRD, UMR Eco&Sols, Place Viala Bat 212 Montpellier, France*

[4]*The Ohio State University, Columbus, Ohio, USA*

Current projections by the International Panel for Climate Change predict that water scarcity, together with incidence of higher temperatures, affect the food production and farming in Sub-Saharan Africa (SSA) now and in the near future. Adaptation is happening but not sufficiently. Native shrubs of the Sahel region influence soil nematofaune and probably its functioning in the benefit of the associated food crops. Soil nematodes play a crucial role in the terrestrial nitrogen cycle by accelerating the release of ammonium from microorganisms (bacteria and fungi). Shrub millet association could be a new biologically-based way to improve production in semiarid agroecosystem and adaptation to climate change. The objective of this work was to evaluate the response of shrub management and water stress on soil nematodes communities. For the field experiment, soil samples were collected from an experimental design where pearl millet (*Pennisetum glaucum*) was cultivated alone or with *P. reticulatum* stands and mulch. A greenhouse experiment was also conducted in a pot with 10 kg of soil collected from the same field under the shrub canopies to assess the water deficit on soil nematode composition. Pots were rewetted to 60% of their water holding capacity (WHC) and pre-incubated in a greenhouse at 30°C ± 3 for one week. Pots were submitted to 3 different levels of irrigation treatments; (1) well-watered (as a control), in which soil moisture was maintained at 80% WHC; (2) moderately water-deficit (moderately stressed), where soil maintained at 40% WHC; (3) severely water-deficit (severely stressed), where soil maintained at 20% WHC over 55 days. The abundance of bacterial feeders was increased in shrub treatments, while no difference was observed on total nematode abundance, however nematodes populations were significantly reduced by water stress (32% of loss).

33. Optimal rice cropping systems under uncertainty: case of West Africa Rice Sector Development Hubs

Lokossou Jourdain[1], Arouna Aminou[2], Atacolodjou Annick[3]

[1]*University of Abomey-Calavi, Benin*

[2]*AfricaRice Centre, Benin*

[3]*Catholic University of West Africa, Benin*

By the end of this century, the world will warm by 4°C if we don't commit now to a concerted action. The consequences will be particularly severe for poor people in developing countries who are the most vulnerable. The projections show that the proportion of undernourished people could rise in the 2050s from 25 to 90% compared to the current situation. It is therefore important to act by reducing emission of greenhouse gases but also by developing adaptation and mitigation strategies for vulnerable populations. This is the aim of this paper which simulates several adaptation and mitigation strategies of climate change to identify the best ones. A stochastic model of rice cropping systems in West Africa was built. The calibration of the model was performed using data of 3054 rice households randomly selected. These data were collected for the cropping year 2012-2013 in the Rice Sector Development Hubs of 10 West Africa countries (Benin, Burkina Faso, Gambia, Ghana, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo). The probability of occurrence of risks associated with climate change has been calculated using climate data, farmers' perception and price changes. The simulations were carried out with General Algebraic Modeling System (GAMS). The key findings show that there is no universal strategy suitable for all countries and all rice cropping systems. However, there is a way for all West African rice producers to significantly reduce the yield gap between a good season and a bad season and be economically efficient even when climate changes are bad. The use of high yielding variety (≥6 tons/ha), short cycle (≤115 days) and sawah technology will allow producers to reduce by 72% the gap between the yield of a bad season and the yield of a good season. Similarly, this strategy allows them to maximize profit and to remain economically efficient from the second year after the installation of sawah, regardless of climate variations. The sawah technology is characterized by leveled rice field surrounded by bund with inlet and outlet connecting irrigation and drainage.

34. Effects of intensification of maize and rice production in Tanzania on productivity and environmental impacts

Brentrup Frank, Mtengeti Ephraim

Yara International ASA, Research Centre Hanninghof, Hanninghof 35, 48249 Duelmen, Germany

Sub-Saharan Africa is facing challenges in terms of food security, reducing malnutrition, and availability of natural resources (*e.g.* water and land). Tanzania is an example for this with a current population of 44 Mio, expected to grow to 183 Mio in 2050. Therefore, the production of maize and rice, which are the most important food crops, has to increase accordingly. Without increasing productivity on existing farmland, substantial land transformation from current savannah, scrubland or forest into cropland is necessary. If this land use change happens, it will result in a significant loss of carbon and biodiversity. The concept of sustainable intensification addresses this challenge by aiming to combine increased crop production per unit of land with reduced environmental impact per unit of crop yield. This concept was tested and examined over 3 years in 12 field trials in maize and rice in Tanzania. Trials were mainly located on smallholder farms. An agronomic protocol including balanced and crop-specific plant nutrition was developed in a public-private partnership with Sokoine University of Agriculture (Tanzania), and the Norwegian University of Life Sciences. After harvest the trials were analyzed regarding crop productivity, profitability to smallholder farmers, and environmental impacts including resource use efficiency, nutrient balances, and carbon footprint. The results show yield improvements in maize of up to 3 times compared with current farmer practice and by an average of 50% for rice. This yield increase translates into environmental advantages for the intensified production system *e.g.* in terms of climate impacts and land use intensity as well as water footprint and water use efficiency. Nutrient balance and N use efficiency calculations indicate depletion of soil fertility in the low-input systems. The trials show that sustainable intensification is possible if crop requirements, available resources and environmental conditions are well balanced.

35. Small farming food versus ethanol sugarcane: global constraints and local opportunities for irrigation in Ghana

Dumas Patrice[1], Brunelle Thierry[1], Souty François[1], Bibas Ruben[1], Méjean Aurélie[1], Lazar Attila[2], Black Emily[2], Vianna Cuadra Santiago[3], Vidale Pier Luigi[2], Verhoef Anna[2], Wade Andrew[2]

[1]*CIRED (CIRAD, ENPC, CNRS, EHESS, AgroParisTech), Nogent-sur-Marne, France*

[2]*University of Reading, Reading, United Kingdom*

[3]*EMBRAPA, Brazil*

To assess the consequences of sugarcane ethanol introduction in Ghana, we compare the profitability and redistribution consequences of mechanized sugarcane and labour-intensive rice. Yield from crop modelling, data on Louisiana mechanized sugarcane cultivation cost, ethanol transformation in Brazil and rice cultivation in Ghana are used to determine economic profitability. In addition to the comparison of sugarcane and rice with current economic conditions, we use projections of future prices to assess long-term profitability, using the Nexus Land-Use global land-use model and the general equilibrium model Imaclim-R. An in-depth sensitivity analysis both on current and future conditions set bounds on profitability.

Assuming irrigation costs typical of Ghana or interest rate higher than 10% would prevent irrigated production from being more profitable than rainfed agriculture. Accounting for future food or fuel price increases, however, favours irrigation. Ultimately, if the interest rates used are sufficiently low and irrigation costs are lower than average costs of past projects in Ghana, the social profitability of irrigation investment rests on future price projections. Irrigation therefore still appears to be a possible option.

With our estimation of social prices, ethanol or sugar production appears to be less profitable than rice production. Uncertainties on prices and irrigation costs, however, prevent from drawing definitive conclusions. With sufficiently high ethanol prices (*e.g.* 2011 prices in Europe, or 2011 Brazil export prices), ethanol could remain more profitable than rice, though an even more risky option.

36. Nutritive quality of dominant forage species in response to simulated drought in sub-tropical native pasture

Talore D.G.[1], Hassen A.[1], Tesfamariam E.H.[2]

[1]*Department of Animal and Wildlife Sciences, University of Pretoria, Private bag 0083, South Africa*

[2]*Department of Plant Production and Soil Sciences, University of Pretoria, Private bag 0002, Pretoria, South Africa*

Understanding how future drought influences plant composition and nutritive value in semi-arid native grasslands is vital to come up with appropriate adaptation options. An experiment was conducted by simulating different levels of drought (control (0%), 15%, 30%, and 60% rainfall intercepted, RI) using rainout shelters in Pretoria, South Africa. Responses of Pangola grass (*Digitaria eriantha*), Pigeon grass (*Setaria sphacelata*), Lehman lovegrass (*Eragrostis lehmannaina*), Spear grass (*Heteropogon controtus*), Elephant's root (*Elephantorrhiza elephantina*, shrub) and *Ipomoea crassipes* (forb) to moisture deficit were examined by monitoring dry matter yield (DM), nutritive value, *in-vitro* gas production (2, 4, 8, 12, 24, 32 and 48 hrs) and fermentation characteristics. The DM yield of grasses ranged between 42 to 258 g m^{-2}, shrub (64 to 90 g m^{-2}) and forb (155 to 411 g m^{-2}). Generally, drought severities associated with shifts in species composition influenced nutritive value and digestibility of the forages. There was a general improvement in the CP content as drought level advanced. The CP content of shrub and forb was higher while their ADF and NDF were lower. Regardless of the drought level, shrub and forb demonstrated higher digestibility and total gas production over grasses. Generally, fractional rate of fermentation and potential degradability were higher in the drought severity treatments (30 and 60% RI). There was positive correlation between digestibility and CP (0.521*) and 24 hr gas production (0.813**) in the 0% treatment, but the correlation pattern changed in the 60% RI treatment. Our results suggest that the drought level of 30% and 60% RI treatments adversely affected yield, but their effect on nutritive value is less evident; the higher moisture deficit could even increase feed quality.

37. Variability of effects of compost on nodulation, N acquisition and yield of cowpea in sub-Saharan areas of Burkina Faso

Zongo Koulibi Fidèle[1], Clermont-Dauphin Cathy[2], Drevon Jean Jacques[3], Blavet Didier[2], Masse Domunique[2], Hien Edmond[1,2]

[1]*UO, Université de Ouagadougou, UFR-SVT, 03 BP 7021, Ouagadougou, Burkina Faso*

[2]*IRD, UMR Eco&Sols, 1 Place Viala, Montpellier, France*

[3]*INRA, Eco&Sols, 1 Place Viala, Montpellier, France*

Legumes/cereals intercropping systems occupy the largest part of the surface area and are the primary food source of people in semiarid tropical regions. Because of drought and low soil fertility, the average grain yields rarely surpass 0.2 t ha^{-1} for the cowpea and 0.3 t ha^{-1} for the millet or sorghum. In the northern region of Burkina, farmers have developed the practice of sowing in bowls of about 15 cm depth and 20 cm diameter, referred to as zaï practice. The zaï bowls are made manually with a hoe. This long and tedious work aims to increase the storage of rainfall-water around the seedlings, and concentrate organic compost application. However, very little data is available on the effects of this organic amendment on the biological N2 fixation, N acquisition and grain yield of the legume. This study aimed at quantifying over three year cycles (2012-2014), the effects of an application of around 9 t ha^{-1} of compost (0.3 kg^{-1} zaï bowl) on nodules number per plant and grain yields of cowpea intercropped with sorghum in 12 farmers' fields. The selected fields represented the various soil types found in this area, and the years of study presented contrasted rainfall patterns. The results showed that the compost application effect on the nodules number per plant varied from highly negative to highly positive depending on the field and the year. The impacts of compost application on the nutrients uptake and yield of the legume were generally positive but also very variable between situations. We will present our analysis of the causes of such variability of the compost effect and will draw the practical consequences for improving these cropping systems in a context of climate change.

Acknowledgment: The work was supported by the Great Federative Project FABATROPIMED of Agropolis Foundation.

38. Potentials of medicinal plants extracts on digestibility, in vitro methane gas production of Eragrostis curvula forage

Akanmu Abiodun Mayowa, Hassen Abubeker

Department of Animal and Wildlife Sciences, University of Pretoria, Pretoria 0002, South Africa

Enteric CH_4 production from ruminants results in loss of feed energy to the animal. It is also one of the major sources of greenhouse gas emission. Medicinal plants have the potential to manipulate rumen microbial ecosystem, which in turn can reduce CH_4 production. The anti-methanogenic activities of some medicinal plant extract (*Piper betle*, *Aloe vera*, *Carica papaya*, *Azadirachta indica*, *Moringa oleifera*, and *Tithonia diversifolia*) were studied using *in-vitro* gas production method. Plant materials were collected, freeze-dried and extracted with 100% methanol. The dried extracts of each of the plants were re-constituted at the rate of 25mg (0.25%) and 50mg (0.5%) in 100ml of distilled water. Their effect on In vitro gas production was studied by adding 5ml of each plant extract solution to vials containing 400mg and 40ml of *Eragrostis curvula* hay and buffered rumen fluid respectively. Three replicates and two control incubations were included in each run. The experiment was repeated 4 times. Total gas and CH_4 production were recorded by taking gas reading and representative samples at 2, 4, 12, 24 and 48 hours after incubation. Dry matter and organic matter digestibility were conducted using standard procedures. Plant extract from *Aloe vera* at 0.25% produced the highest volume of gas (53.65ml), followed by *Moringa oleifera* at 0.25%, and Carica Papaya at 0.25%. However, the ratio of CH_4 to total gas production was lowest 12.65% in 0.5% Azadirachta indica, while the highest was produced by 0.5% *Aloe vera* and 0.5% *Piper betle* with values of 23.17% and 21.75% respectively. The extracts of *Piper betle* and *Tithonia diversifolia* produced the most significant ($P<0.01$) results on IVOMD while others showed significant better results in OMD and DMD those of the controls. Azadirachta indica, *Tithonia diversifolia*, *Piper betle* and *Carica papaya* have the potentials to reduce rumen CH_4 production and increase feed digestibility.

39. Food security patterns at farm household level: key drivers and options for climate-smart agricultural interventions

Wichern Jannike[1], Descheemaeker Katrien[1], van Wijk Mark[2], Giller Ken[1]

[1]*Wageningen UR, Plant Production Systems, 6708 PB Wageningen, The Netherlands*
[2]*International Livestock Research Institute, 00100 Nairobi, Kenya*

East Africa's smallholder agriculture is expected to be heavily affected by climate change, which, together with a growing population, will result in an increasing challenge to achieve food security for households and regions. Food security is one of the three pillars of climate-smart agriculture (CSA), a concept currently promoted to East African policy makers, who are challenged to increase food security in a changing climate. These policy makers need information that can guide their decision making on how and in which regions to promote which CSA interventions. For this, we need to better understand what drives food security at household and regional scales and identify current food security patterns. This will help to predict potential impacts of climate change and specific CSA interventions on regional food security. This study aimed at revealing spatial patterns of food security across Uganda and Tanzania and at identifying factors that explain household level food security to determine key regions for CSA interventions. Multi-year household data from datasets of the World Bank and the CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS) were used to determine simple household level food security indicators. Using spatial statistics, clusters of homogenous food security status were identified. Spatial information on market access, road infrastructure, agroecology, livelihoods and farming systems was associated with the household level food security indicators using GIS. Based on regression and multivariate analyses, relations between spatial characteristics and food security indicators were determined and food security levels could be identified for different regions. Food security maps were produced and areas of high vulnerability to food insecurity identified. The maps and the knowledge on food security drivers can provide a basis for decision making in policy to target areas for CSA interventions in the future.

40. Analysis of the impact of climate changes in the last thirty years on the second generation of cocoa in Côte d'Ivoire

Kassin Koffi Emmanuel[1], Yao Guy Fernand[1], Diedhiou Arona[2], Koko Louis Kan Anselme[3], Assiri Assiri Alexis[3], Kouamé Brou[1], Konaré Abdourahamane[4], Kouassi Koffi Nazaire[5], Yoro Gballou René[1]

[1]*National Center of Agronomic Research (CNRA), Central Laboratory of Soil, Water and Plants, Sustainable Management of Soil and Water Control Program, 01 633 BP 01 Bouaké, Ivory Coast*

[2]*Institute of Research for Development (IRD), University of Grenoble Alpes, LTHE, BP 53, 38041 Grenoble Cedex 9, France*

[3]*National Center of Agronomic Research (CNRA), Cocoa Program, BP 808 Divo, Ivory Coast*

[4]*Félix Houphouët-Boigny University of Cocody, UFR SSMT, Laboratory of Atmospheric Physics and Fluid Mechanics (LAPA-MF), 22 BP 582 22 Abidjan, Ivory Coast*

[5]*National Center of Agronomic Research (CNRA), Central Laboratory of Biotechnology (LCB), 01 BP 1740 Abidjan 01, Ivory Coast*

Côte d'Ivoire is the world's largest cocoa producer before Ghana, with about 1,300,000 tons of production, which represents 40 % of world production. However, the Ivorian cocoa sector is facing in recent decades difficulties to plant a new generation of cocoa. Attempts by growers to renew their aging orchards often failed due to, among other things, the cumulative rainfall deficits over the seasons and years, and the inadequacy of the current crop calendar in the present climatic context. This study, conducted in the center-west of Côte d'Ivoire aims to analyze the evolution of rainfall over the last 37 years, to assess climate risks for cocoa and determine the suitable period of establish new cocoa farm, ensuring the survival of young trees during replanting. Agro-climatic data were collected at the agronomic research stations of Divo and Gagnoa. The comparison between climatic parameters and the water needs of cocoa shows that the favorable period of implementation of cocoa in the current climate context of the study area is between March and April and not between May to June as recommended since the 1960s, to enable young trees to take advantage of the long rainy season. Finally a strategy of implementation the second generation of cocoa taking into account the climate change observed over the region and future change simulated by some CORDEX-Africa regional models is proposed.

This study is supported by the Regional Multidisciplinary Platform SREC on rural communities, environment and climate in West Africa and contributes to the AMMA international program objectives on climate services.

41. Carbon footprinting of the Irish potato production systems in Zimbabwe

Svubure Oniward[1,2], Struik Paul C.[2], Haverkort Anton J.[3,4], Steyn Martin J.[4]

[1]*Chinhoyi University of Technology, Department of Irrigation and Water Engineering, PB 7724, Chinhoyi, Zimbabwe*

[2]*Centre for Crop Systems Analysis, Wageningen University and Research Centre, 6700 AK Wageningen, the Netherlands*

[3]*Plant Research International, Wageningen University and Research Centre, 6700 AP, Wageningen, the Netherlands*

[4]*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa*

Agriculture contributes significant quantities to the world greenhouse gas (GHG) emissions. Farmers need to fine-tune agricultural practices to optimise between productivity to feed a growing global population and lowering GHG emissions to mitigate climate change. Major emission sources in cropping include production of synthetic fertilisers, biocides manufacture and use, fossil fuel combustion in tractor use, soil-related emissions and other practices. In this study, grower survey on practically all aspects of Irish potato in the major growing areas of Zimbabwe provided input data into the 'Cool Farm Tool-Potato' model. The model calculates and displays in its output the total GHG emission both on a per-hectare and per-ton potato basis and its composition. Experienced growers were targeted and all had good knowledge of their cultural practices. The average carbon footprint calculated was 253 kg CO_2 eq/t potato, ranging from 216 to 297 kg CO_2 eq/t in the Communal and A2-resettlement production systems respectively. The major driver of the CO_2 emissions was fertiliser production which accounted for an average of 38 % of the total emissions across all the production systems. A significant ($p < 0.05$; R2 = 0.64) relationship was found between the total CO_2 emissions and the CO_2 emission originating from fertilisation. On a per-hectare basis, significant differences ($p < .001$) in total emissions were found between the four potato production systems. The total GHG emissions range from 1,946 to 6,211 kg CO_2 eq/ha in the A1-resettlement and large-scale commercial production systems respectively. Though mitigation options were not assessed, the model output displays the factors/farm operations and their respective emission estimates hence allowing the grower to choose the operations to lower the carbon footprint. Opportunities for benchmarking, as an incentive to improve emission performance, exist because of a large variation in GHG emission among the growers.

42. Farmers' access to agrometeorological services in Ido local government area of Oyo state, Nigeria

Ewebiyi I.O.[1], Olayemi O.O.[2], Osikabor B.[2], Aluko, O.J.[2], Samuel O.F.[2]

[1]*Department of Agricultural Science, College of Science and Information Technology, Tai- Solarin University of Education, Ijebu ode, Ogun state, Nigeria*

[2]*Department of Agricultural Extension and Management, Federal College of Forestry, Forestry Research Institute of Nigeria, Ibadan, Oyo state, Nigeria*

Agrometeorology has advanced over decades from a descriptive to a quantitative science using physical and biological principles. Now, the challenge is to balance the continuing need for increased productivity with new and growing concerns about climate change, climate variability and the associated environmental impacts. The farming community in Nigeria especially is becoming more and more aware of weather and its impact on the crop at different phenological stages. During this decade, farmers' awareness also increased substantially about the increasing and efficient agrometeorological services, mainly weather-based agro-advisory services. The business community is now gearing up its activities based on monthly weather forecast along with the agro-advisories and it needs to be addressed immediately by the agrometeorologists.

The study was designed to assess the Farmer's Access to agrometeorological services in Ido Local Government of Oyo State, Nigeria. Specifically, it described the personal and socio-demographic characteristic of the respondents (Farmers), determined the level of awareness of respondents (Farmers) of agrometeorological services, identified the major sources of information of agrometeorological services, and determined the respondents' accessibility to agrometeorological services and constraints militating against their awareness.

Multi sampling techniques were used to select respondents. Structured questionnaires were administered through interviews. Interview schedule was used to elicit quantitative information from the respondents. Frequency counts, percentage and mean were used to summarize and describe the data, while Pearson correlation was used to make inferences. The result showed that the mean age of the respondents was 44.29 years. More males were involved in farming activities than females. A majority of the respondents had education, 22.0% had tertiary education, 35.0% secondary education, 22.0% primary education, 2.0% for vocational and 19.0% had no formal education. Both farmer's Association and Extension Agent served highest as a source of information with 80.0% of the respondents, followed by Radio with 61.0% but their contact with agrometeorological station is poor (2.0%). The Pearson correlation analysis showed that $P \leq 0.01$ significant level, age ($r = -0.24803$), sex ($r=-0.23704$), marital status ($r=-0.24236$) and household ($r=-0.28963$) had significant but inverse relationship with their perception level. Moreover at $P \leq 0.01$, religion ($r=0.03783$), education ($r=0.104002$) had positive and significant relationship with their level of perception. It is therefore concluded that Farmer's accessibility in the study area, their level of awareness and constraints are inversely related to each other, *i.e.* the higher the level of constraint among the farmers, the lower would be the level of accessibility to agrometeorological services. The more the farmers (respondents) are constrained, the less they will have access to agrometeorological services, and vice versa.

43. Impact of dry-wet cycles on carbon mineralization of tropical soils

Yemadje Pierrot Lionel[1,2], Guibert Hervé[1], Bernoux Martial[2], Deleporte Philippe[3], Chevallier Tiphaine[2]

[1]*CIRAD, UPR AIDA, F-34398 Montpellier, France*

[2]*IRD, UMR Eco&Sols, Campus SupAgro Bâtiment 12, 2 place Viala, 34060 Montpellier Cedex 2, France*

[3]*CIRAD, UMR Eco&Sols, Campus SupAgro Bâtiment 12, 2 place Viala, 34060 Montpellier Cedex 2, France*

In the context of climate change, the increase of dry-wet cycles could cause large losses of soil carbon stock. Located in the Sudano-Sahelian region, soils of North Cameroon experience dry periods followed by erratic rains at the beginning of the cropping season. This study was conducted during the dry season in North Cameroon and aimed to assess the impact of dry-wet cycles on carbon mineralization of soil. These soils were subjected to two differentiated managements of soil cover, mulch of straw residues and without mulch. For each soil, four water supply schemes were applied: permanently dry soil as a reference, permanently moist soil, soils subjected to five and to ten dry-wet cycles. Soil respiration, soil temperature and moisture were measured using four repetitions per plot during fifty days with an infrared gas analyzer and probes. The frequency of dry-wet cycles moderately increased the total soil carbon mineralization on a cultivated soil and mulched regularly. On this soil, ten dry-wet cycles caused a cumulated C mineralization of 1.32 $tC.ha^{-1}$ on 50 days against respectively 1.17 and 1.15 $tC.ha^{-1}$ on soils with five dry-wet cycles and permanently moist soils. In the absence of mulch, frequency of dry-wet cycles moderately decreased the total soil carbon mineralization. Ten dry-wet cycles caused a cumulated C mineralization of 0.74 $tC.ha^{-1}$ on 50 days against respectively 0.93 and 0.94 $tC.ha^{-1}$ on soils with five dry-wet cycles and permanently moist soils. Our results indicated that in tropical agro-ecosystems, the frequency of dry-wet cycles and management of soil might induce changes in the dynamics of soil carbon and should be considered into the simulation models of soil carbon.

44. Impact of climate change and desertification on agriculture and food security in Côte d'Ivoire

Kassin Koffi Emmanuel[1], Yao Guy Fernand[1], Diedhiou Arona[2], Kouamé Brou[1], Konaré Abdourahamane[3], Kouassi Koffi Nazaire[4], Yoro Gballou René[1]

[1]*National Center of Agronomic Research (CNRA), Central Laboratory of Soil, Water and Plants, Sustainable Management of Soil and Water Control Program, 01 633 BP 01 Bouaké, Ivory Coast*

[2]*Institut de Recherche pour le Développement (IRD), Université de Grenoble Alpes, LTHE, BP 53, 38041, Grenoble Cedex 9, France*

[3]*Félix Houphouët-Boigny University of Cocody, UFR SSMT, Laboratory of Atmospheric Physics and Fluid Mechanics (LAPA-MF), 22 BP 582 22 Abidjan, Ivory Coast*

[4]*National Center of Agronomic Research (CNRA), Central Laboratory of Biotechnology (LCB), 01 BP 1740 Abidjan 01, Ivory Coast*

The statistics from the Economic Community of West African States (ECOWAS) showed that in 2010, Côte d'Ivoire still accounted for 60% of agricultural exports of the region. To reduce the adverse effects of climate change on this sector and on food security, the Government supports activities of research and development for the sustainable adaptation of agriculture to climate change. This multidisciplinary study aims to analyze the evolution of intraseasonal variability of rainfall in Côte d'Ivoire from 1950 to 2007, including changes in behavior of the rainy seasons and impact of climate change on agricultural production. Cross analysis between hydroclimatic data, agricultural practices, land use and land cover changes and the agricultural production statistics in Côte d'Ivoire is performed during the period. A significant decrease in water resources over the past few years is found after the year 1970 with a high risk of crop loss for food crops whose cycles are beyond 100 days. In addition to these crop losses, the change in effective dates of onset of rains led to a disruption of crop calendar and a change in land use along the landscape. Finally, data from CMIP5 models were used to study in the near future (2030 - 2050) and in the distant future (2080 - 2100) changes in the length of the rainy season and in the behavior of climatic events with high impact on agriculture. This study is supported by the AMMA international program on the African Monsoon and contributes to the Regional Multidisciplinary Platform SREC on rural communities, environment and climate in West Africa.

45. Exploring institutional dimension of climate-smart agriculture in Nigeria

Fanen Terdoo[1], Olalekan Adekola[2]

[1]Department of Geography and Environmental Science, University of Reading, United Kingdom

[2]Department of Geography, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria

This study explores the formal and informal rules as well as organizational arrangements governing climate change adaptation, mitigation, and sustainable agricultural intensification in northern Nigeria. Interviews were conducted with various sectors including banking, government, local communities and non-governmental organizations to identify opportunities and barriers towards climate smart agriculture. Interview data was completed with analysis of secondary source data. Results show that all the organizations have existing rules promoting climate change adaption, mitigation and sustainable agricultural intensification, which is not expected to change. However, actual practices were found to be different from the formal rules such that these practices often are barriers to promoting climate smart agriculture principles. For example, foremost among the efforts made in the past were: creation of awareness for the need to protect the environment, promotion afforestation/tree planting practice/campaigns among farmers, establishment of private woodlots, and canvasing for the establishment of monitoring agencies at local and state level. While there is substantial effort by stakeholders formulating formal rules and promoting activities awareness creation and community sensitization, there is general lack of monitoring to ensure that the tenets of these formal rules are actually kept in practice. One reason for this disparity is the lack of understanding of formal policy documents/rules by the implementers who are often not included in the drafting of the formal rules. We conclude that climate smart agricultural experts should give greater attention to the participatory development of institutions in this field. Such an approach, rarely available, could hold the key to reducing disparity between stated and actual institutions and practices.

46. Critical reflection on knowledge and narratives of conservation agriculture in Zambia

Whitfield Stephen, Dougill, Andrew J., Dyer Jen C., Kalaba, Felix K., Leventon Julia, Stringer Lindsay C.

Sustainability Research Institute, University of Leeds, Leeds, LS2 9J, United Kingdom

In the context of contemporary concerns about climate change and food security, conservation agriculture (CA) has emerged as a well-supported and central component of the agricultural sector development strategy across sub-Saharan Africa, including in Zambia. A variety of narratives about the benefits of CA over conventional agricultural systems underpin endeavours towards 'scaling up' CA and increasing rates of adoption amongst smallholder farmers nationwide. However, there is a knowledge politics underlying the translation of a weak evidence base around CA into persuasive narratives and financial and political support. Here we trace the evolution of five narratives around CA in Zambia in relation to changing political agendas and the involvement of new public and private sector actors, and review the development of evidence bases and knowledge that support and challenge each of these narratives. We discuss the potential for opening up space within this knowledge politics to alternative narratives and contestation of the CA scaling up agenda.

47. Positive effect of climate change on cotton and rice in Africa and Madagascar

Gerardeaux Edward[1], Krishna Naudin[1], Ramanantsoanirina Alan[4], Dusserre Julie[1], Oetli Pascal[2], Oumarou Palai[3], Sultan Benjamin[2]

[1]*CIRAD, Avenue Agropolis - TA B-102 / 02 - 34398 Montpellier Cedex 5, France*

[2]*LOCEAN, IRD, Université Pierre et Marie Curie Boite 100, 4 Place Jussieu, 75252 Paris Cedex 5, France*

[3]*Sodecoton, 3Centre Régional de Recherche Agricole de Maroua, BP 33 Maroua, Cameroon*

[4]*Fofifa, Antsirabe, Madagascar*

The increase in temperature and in carbon dioxide as well as rainfall uncertainty associated with global warming could have serious consequences for crop production, especially for rainfed systems in Africa and Madagascar. It is therefore important to assess the potential impact of climate change on cotton and rice production for future climate change scenarios. We used DSSAT models, a set of process-based crop models, which can realistically simulate the main features of several crops such as cotton or rice. The models were calibrated and validated with data sets of observations made in farmers' fields and experimental stations in 2008 to 2011, with different cropping systems. Our main results show that climate change from 2005 to 2050 in North Cameroon or Madagascar will have a positive effect on both cotton and rice yields. The predicted increase of 0.05 °C yr^{-1} in temperature will shorten crop cycles by 0.1 to 0.2 d yr^{-1} with no negative effect on yields. Moreover, the fertilizing effect of CO_2 enrichment will increase yields by approximately 30 to 50 kg ha^{-1}. Our results are in discordance with the mainstream of pessimistic predictions for crop yields in Africa. The reason for this discrepancy comes from the specific conditions: in North Cameroon, some GCM predicts an increase in rainfall amount and in Madagascar Highlands, low temperatures are an important limiting factor for growth. Moreover cotton and rice have a metabolism for photosynthesis in C_3. Thus they are more sensitive to carbon enrichment than C_4 crops (Maize, Sorghum…).

48. Modeling potential impact of climate change on sorghum and cowpea yields in semi-arid areas of Kenya

Kitinya Kirina Thomas[1], Onwonga Richard N.[2], Kironchi Geoffrey[2], Mbuvi Joseph P.[2]

[1]*SNV Netherlands Development Organization-Cambodia, Premier Office Centre (POC), #184, Street 217 (Monireth), PO Box 2590, Phnom Penh, Cambodia*

[2]*Land Resource Management and Agricultural Technology (L.A.R.M.A.T), College of Agriculture and Veterinary Sciences, University of Nairobi, P.O. Box 29053-00625, Nairobi, Kenya*

Crop models can be used to asses risks associated with climate change (CC). Field trial was conducted in Wote district, Kenya, during the long rains of (LRS) 2010 and short rains (SRS) 2010/2011 capturing different tillage and cropping system for sorghum and cowpea to provide base data for crop modeling. Agricultural Production System Simulator Model (APSIM) was used to assess the potential impact of CC on biomass and grain yields. For CC, elevated temperatures by 1°C (T1), 2°C (T2) and 3°C (T3) and 10% reduction in rainfall (R1) were considered against base temperature (T0) and rainfall (R0). For Cowpea, Carbon dioxide (CO_2) fertilization at 450ppm and 700ppm and their combination with T2 and T3 (R1) was also examined. There was no significant difference ($p= 0.54$) between simulated and observed biomass yields with $r2 = 0.74$ and RMSE of 408 kg ha^{-1} for sorghum during SRS indicative of a good model performance. Cowpea biomass yield was reasonably predicted ($r2=0.665$), but grain yield prediction was poor ($r2=0.02$). On average, the combined effect of increase in temperature by 1°C, and 2°C and rainfall reduction by 10%, resulted in a percentage reduction in biomass and grain yields by 5.5% and 5.6% in sorghum and 17% and 23% in cowpea. Elevated CO_2 at 450 ppm had a positive effect on cowpea biomass, showing an increase of 7% and 0.8 % in yields despite temperature increase by 2°C and 3°C respectively. Higher temperatures of 2°C and 3°C accelerated crop growth, leading to early maturity by 5 and 7 days for Cowpea and by 3 and 4 days observed in Sorghum. APSIM model demonstrated capacity to simulate potential impact of CC. This study provides a basis for improvement of modeling efforts especially in parameterization and capture of different tillage and intercropping aimed at building resilient adaptation options for small holder farming.

49. Gender analysis of adaptation strategies of water stress among crop farmers in Asa local government area of Kwara State

Samuel O.F.[1], Aluko O.J.[1], Adejumo A.A.[2]

[1]*Department of Agricultural Extension and Management, Federal College of Forestry Ibadan, Forestry Research Institute of Nigeria, P.M.B 5087, Dugbe, Ibadan, Nigeria*

[2]*Department of Agricultural Extension and Rural Development, University of Ibadan, Nigeria*

Concern over the potential effects of long-term climatic change on agriculture has motivated a substantial body of research over the past decade. This body of research addresses possible physical effects of climatic change on agriculture, such as changes in crop yields and other aspects of agriculture, as well as the economic consequences of these potential yield changes. This study was carried out to determine the adaptive strategies of water stress employed among arable crop farmers based on Gender in Asa Local Government Area of Kwara State. Data were collected through the use of interview schedule and analyzed using frequencies and percentages to present the descriptive analysis, while Pearson Product Moment Correlation and Chi- Square were used for inferential analysis. The findings of the study revealed that the average age of male and female respondents in the study area was 37, 82.1% were married and had no formal education (63.2%). Majority (70.0%) had small farm size of range 1-5 acres. Vegetable, cassava, maize, sorghum, yam and sweet potatoes were major arable crop cultivated by the respondents in the study area. Poor credit facilities, insufficient water supply and high cost of human labour were major constraints faced by the farmers in the study area. Findings from the study revealed that female farmers employed more of the adaptive strategies when compared to their male counterparts. Age ($r = 0.172$), farm size (0.102) and level of education ($\chi^2 = 3.921$) were found to have significant relationship with adaptive strategies of water stress employed among arable crop farmers. Significant difference also existed in the adaptive strategies of water stress along gender line. It is concluded that both men and women are involved in arable crop production in the study area and both experience water stress but female farmers reported a high level of water stress than men. The study recommended that women arable crop farmers should be given access to resources, and irrigation system should be provided for both male and female arable crop farmers.

50. Matching uses and functional traits of companion trees in cocoa agroforests: a win-win scheme toward resilient systems

Saj Stéphane[1,2], Jagoret Patrick[3]

[1]*UMR System, CIRAD, Direction Régionale, BP 2572, Yaoundé, Cameroon*

[2]*IRAD, Programme Plantes stimulantes, Direction Nkolbisson, Yaoundé, Cameroon*

[3]*UMR System, CIRAD, Bât 27, 2 place Viala, 34060 Montpellier Cedex 2, France*

Africa's cocoa producing countries are currently challenged to design climate-smart cropping models that would satisfy both growers and manufacturers. In this context, Cameroon's cocoa-based agroforestry systems (c-AFS), could serve as a model. Compared with prevailing monoculture systems, these c-AFS significantly support biodiversity conservation and C storage while providing farmers with sustainable low-but-steady cocoa yields. Such a result largely relies on farmers' use of tree diversity since, for example, these c-AFS are not fertilized. We herein check for a putative method helping to better understand the functioning of these very complex systems while including farmers' multiple use of tree diversity.

We studied 58 1000m^2 c-AFS plots across Central Cameroon. We surveyed farmers' use of companion trees and grouped them in 4 categories: (a) wood- or (b) food production, (c) assumed agronomical support to cocoa growing, (d) other /unknown use. We further checked for 5 functional traits (i) N-fixation, (ii) shade tolerance, (iii) strata, (iv) wood specific gravity; (v) leaf life-span strategy. Out of the 1258 trees recorded, 688 individuals from 50 species could be used to run Multiple Correspondence Analysis (MCA). MCA distinguished between three groups: (1) trees used for their wood appeared to be mainly dominant, of hard wood, and deciduous; (2) pioneer and light wood trees were mainly used to support cocoa growth; (3) food producing trees were mainly evergreen and belonged to the same dominated strata as cocoa.

It appears that such clustering helps gauging tree diversity contribution to cocoa yield and shows trades-off or synergies within the system per se as well as between growers' various objectives. Hence, it should help designing/enhancing c-AFS that inherently consider farmers' objectives and local tree species. Furthermore, such method allows climate-smart modelling of c-AFS thanks to the management of ecological functions supported by its tree component.

51. Water requirements for potato production under climate change

Farag A.A.[1], Abdrabbo M.A.[1], Gad EL-Moula[1], Manal M.H.[1], McCarl B. A.[2]

[1]*Central laboratory for Agricultural Climate (CLAC), Agricultural Research Centre, Giza, Egypt*

[2]*Department of Agricultural Economics Texas A&M University, Texas, USA*

In support of research to predict the impact of climate change on reference evapotranspiration (ETo) in Egypt, this study investigates the projected changes in evapotranspiration in Egypt, with a focus on the Delta, Middle and Upper Egypt. The maximum and minimum temperature were statistically downscaled and compared with a current climate, defined as the period 1971–2000. FAO-56 Penman-Monteith equation was used to estimate ETo by using the climatic data. Evapotranspiration is estimated based on the predicted maximum and minimum using the RCPs scenarios (RCP3.0 – RCP4.5 – RCP6.0 and RCP8.5) during three time series (2011-2040, 2041-2070 and 2071-2100). The obtained results revealed that the maximum and minimum air temperatures were increased under all RCPs scenarios compared to current data. Moreover, the RCP8.5 had the highest maximum and minimum air temperature compared to the other RCPs scenarios. It was found that for all future periods the annual evapotranspiration will increase for the all agro-meteorological zones by uneven values. The main results in this study revealed that ETo significantly increased in different tested time series compared to current ETo values. The values of ETo in long term (2071-2100) were higher than short (2011-2040) or mid-term (2041-2070) with respect to the current situation. The highest ETo values was predicted in this study by RCP8.5 during the 2071 – 2100 time series in the Upper Egypt region. The estimation of water requirements for potato crops in different agro-climatic zone show that winter season had the highest cultivated area with potato followed by summer season. Upper Egypt region has the lowest cultivated area of potato during different cultivation season. Total water requirements (WR) for potato during the different cultivating seasons revealed that WR will increase under all scenarios in comparison with the current conditions. The highest water use efficiency was recorded in the Upper Egypt climatic zone during the winter season at 2012. Winter season gave the highest water use efficiency under (WUE) current and future conditions. Moreover, all RCPs scenarios had lower WUE than the current conditions during different time series. Regardless of the seasons, the RCP8.5 gave the lowest WUE in comparison with the other RCPs scenarios.

52. How smart is Climate Smart Agriculture (CSA)? – Lessons from Northern Nigeria

Adekola Olalekan[1], Terdoo Fanen[2]

[1]*Department of Geography, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria*

[2]*Department of Geography and Regional Planning, Federal University Dutsin-Ma, Katsina State, Nigeria*

Climate-smart agriculture (CSA) raises the hope that African farmers can increase agricultural productivity and adapt, build resilience to climate change and reduce emissions of greenhouse gases emanating from their practices. However, little literature reports research regarding perceptions and knowledge of farmers as to how this approach can fulfil its potentials especially in Africa. This paper presents a study based on interviews and group discussions conducted among farmers in Northern Nigeria. We address five main questions, namely (i) do farmers think CSA is specific enough to address the challenges they face (ii) can the success (or failure) of CSA be adequately measured (iii) considering local situation, is CSA achievable (iv) is CSA realistic or does it sound idealistic and (v) can the objectives of CSA be achieved in a timely manner? We found that the strength of CSA lies in its ability to integrate agricultural productivity with environmental targets. The results indicate that for any approach to be successful it has to among other things address the livelihood needs and cultural biases of local farmers. We also identified differences in the perception between different groups within the society. Younger farmers who possess little farmlands showed optimism in the potentials of CSA approach in addressing livelihood and environmental challenges, the older farmers with larger farmlands were generally uncertain and suspicious. This analysis could be used to identify target group to focus CSA management issues on i.e. if it is assumed that groups with significantly greater proportion farmlands could have more impact on the environment. We suggest continuous effort to develop knowledge and build capacities of local farmers and experts. Lesson from this study are important in developing the knowledge and capacities that will make CSA a reality. Therefore, further studies across Africa which take local specificities and priorities into consideration are needed.

53. Integrating climate smart agriculture for food security: the role of private sector investment in Africa

Kalimunjaye Samuel[1,2], Olobo Maurice[1], Kisenyi Vincent[1], Essegu J.F.[2], Okatono Isaac[1]

[1]*Uganda Christain University Mukono P.O.Box 4 Mukono Faculty of Business and Administration, Uganda*

[2]*National Agricultural Research Organisation/National Forestry Reseources Research Institute P.O.Box 1752 Kampala, Uganda*

In Uganda, because of a mix of climate change impacts, business managers are struggling to leverage organisational resources beyond normal business operations. This is to enhance the targeting of private sector enterprises in the market for linkage that have multiple goals throughout the value chain. The capital base and raw material sources for these companies have been constrained in adapting to the harsh conditions provided by the market due to climate change effects, making it hard for these companies to be profitable and competitive. This study assessed corporate carbon financing strategies and competitiveness of private sector enterprises under different management practices in Uganda. We used correlation analysis to find out the relationship, and found there was positive association between company factors and competitiveness. However, the study recommended an integrated carbon financing model with double edged approaches for corporate companies to gain competitive advantage in their strategies for the dynamic markets/interventions in Uganda.

54. Climate variability and Impacts on the population of leaf miner, a pest of the Oil Palm in Nigeria

Aneni Thomas, Aisagbonhi Charles

Nigerian Institute for Oil Palm Research (NIFOR), Entomology Division, 30001, Benin-City, Nigeria

This study examines the impact of climate variability on abundance on the leaf miner, *Coelaenomenodera elaeidis*, a major pest of the oil palm in Nigeria and its parasitoids. The study analyses temperature, rainfall and relative humidity conditions from 1961-1970 as reference point for baseline climatic conditions and description of same conditions between 2001-2010 to demonstrate patterns in climate change and variability in the study area; evaluates climate change and variability projections up to 2050; and describes impacts of climate variability on leaf miner abundance in the study area. The leaf miner was sampled in the Nigerian Institute for Oil Palm Research, between January 2009 and December 2010. Past population estimates from 1979-1980 were utilized. Means, standard deviation, variances, covariance's, seasonal and climatic patterns were computed. Least square method was used to estimate the trend in the series and the trend equation. Rising temperatures were observed between 1961 and 2010 with 2001 – 2010 being the warmest period. In this study, temperature forecast is projected to increase by 1.4 °C by 2050 based on trend analysis using 2001 – 2010 as baseline values. This could imply further proliferation of the leaf miner by 2050. Time series analysis was used to analyse the data and generate trend equations. The models for temperature, rainfall and relative humidity are $Yt = 30.6174 + 3.51E\ -02*t$; $Yt = 163.829 - 0.112521*t$ and $Yt = 68.8473 – 230E\ -02*t$ respectively where t is time. On this basis, a forecast up to 2050 was generated. Specific forecast indices for 2050 are: Temperature: 33.8 °C; Rainfall: 153.70mm; and Relative humidity: 66.8%. The study has established an upward increase in temperature, attributed to climate change, with concomitant increase in leaf miner abundance between 1980 and 2010.

L1.2 Australasia

55. The agro-potential of Western Siberia territories in a changing climate

Nikitich Polina[1,2,3], Bredoire Felix[4,5], Alvarez Gaël[6], Barsukov Pavel[7], Bakker Mark[8], Buée Marc[9], Derrien Delphine[1], Fontaine Sebastien[6], Kayler Zachary[10], Rusalimova Olga[7], Vaishlya Olga[2], Zeller Bernd[1]

[1]*INRA Nancy-Lorraine - Biogeochemistry of Forest Ecosystems, Champenoux, France*

[2]*Tomsk State University, Tomsk, Russia*

[3]*Université de Lorraine, Vandoeuvre les Nancy, France*

[4]*INRA Bordeaux-Aquitaine - UMR 1391 ISPA, Villenave d'Ornon, France*

[5]*Université de Bordeaux, Bordeaux, France*

[6]*INRA Clermont - UREP, Clermont Ferrand, France*

[7]*Institute of Soil Sciences and Agrochemistry, Novosibirsk, Russia*

[8]*Bordeaux Sciences Agro, UMR 1391 ISPA, Gradignan, France*

[9]*INRA Nancy-Lorraine - Interactions Arbres-Microorganismes, Champenoux, France*

[10]*Institute for Landscape Biogeochemistry - ZALF, Müncheberg, Germany*

Siberian studies performed over the last decades have detected a general increase in temperature and an increase in winter precipitation leading to a thicker snow pack. Climate models predict an amplification of these trends and indicate that the huge territory of the western Siberian plains will become suitable for agriculture. However, the projections do not consider soil fertility—a key issue for agricultural sustainability. The intention of our study is to test whether the predicted increase in snow precipitation will change the soil water fluxes, soil organic matter (SOM) decomposition, and the rate of nutrient release caused by reduced soil freezing.

Investigations were performed in forests and grasslands close to Barnaul, in the steppe zone, and close to Tomsk, in the taiga zone. The sites were characterized for their climate, snow cover, pedoclimate and root patterns. A pair plot experiment was conducted to investigate the effect of snow thickness on soil temperature, moisture, and on the release of nutrients during SOM decomposition. Snow cover was artificially increased in the treatment plot and was undisturbed in the control plot. The impact of snow thickness on soil moisture and temperature was continuously monitored over one year. The release of nitrogen (N) from decaying litter was investigated using 15N isotope tracing. Enzyme activities relevant to the release of N and phosphorus (P) from SOM were measured.

At all sites, N and P stocks were large, with organic P representing a high proportion of total P in the topsoil. The increase of snow cover raises the soil T°C over winter and enhances the soil water content after snowmelt. It impacts enzyme activities and the release of N from decomposing litter.

These results showed that climate change in Western Siberia may affect soil fertility and the potential of soils to sustain agriculture after conversion of forest and grassland into cropland.

Acknowledgements to EraNET-RUS and ACCAF metaprogramme

56. Ecological intensification through conservation agriculture in Cambodia: impact on SOC, N and enzymatic activities

Tivet Florent[1,2], Hok Lyda[3,4], Boulakia Stéphane[1], de Moraes Sá João Carlos[5], Kong Rada[2], Leng Vira[2], Briedis Clever[5]

[1]*Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), UR AIDA/CSIA, Avenue Agropolis, 34398 Montpellier, France*

[2]*Ministry of Agriculture, Forestry and Fisheries, General Directorate of Agriculture, Conservation Agriculture Service Centre, Phnom Penh, Cambodia*

[3]*Department of Soil Science, Faculty of Agronomy, Royal University of Agriculture, P.O. Box 2696, Phnom Penh, Cambodia*

[4]*Department of Natural Resources and Environmental Design, North Carolina A&T State University, Greensboro, NC 27411, USA*

[5]*Department of Soil Science and Agricultural Engineering, State University of Ponta Grossa, Av. Carlos Cavalcanti 4748, Campus de Uvaranas, 84030-900, Ponta Grossa, PR, Brazil*

Cambodia has been identified to be one of the most affected countries by climate change. In the past two decades, migration from the central plains to the peripheral areas changed drastically the development of the uplands, inducing tremendous degradation of natural resources. The promotion of cropping systems based on ecological intensification is of paramount importance to strengthen the resilience of small-scale farming, to mitigate the effect of climate change and to advance in farm sustainability. The aim of this study was to quantify the short-term impact of conservation agriculture (CA, direct seeding + use of cover/relay crops), on soil organic C (SOC), soil total N (STN), labile C fractions (particulate organic C - POC and permanganate oxidizable organic C - POXC), β-glucosidase and arylsulfatase activities. Established in 2009, the experimental plots were laid out in a randomized complete block design (3 replicates) with: (i) soybean under conventional tillage (CT), (ii) soybean under conservation agriculture (CA1), and (iii) soybean in bi-annual rotation with maize under conservation agriculture (CA2). Several cover/relay crops were associated prior to and with the main crops. Soil sampling was conducted in 2011 and 2013 at 0-5, 5-10, 10-20, and 20-40 cm depths. Biomass-C inputs ranged from 2.2 to 7.8 Mg C ha^{-1} yr^{-1} under CT and CA respectively, emphasizing the difference of supply of fresh organic matter. On average, CA increased SOC and STN stocks at 0-5 cm depth by 20% and 25% when compared with CT. β-glucosidase and arylsulfatase activities at 0-5 cm depth was 28% and 36% greater in CA1 and CA2 soils. In addition, CA2 (rotational sequence and higher biomass-C inputs) showed a better increasing trend of labile C fraction (HWEOC and POXC) and β-glucosidase and arylsulfatase activities than CA1. Conservation agriculture shows potential for the long term improvement of Cambodia uplands.

57. Net ecosystem exchange of carbon dioxide and methane in rice fields of northern Indo-Gangetic Plains

Bhatia A.[1], Kumar A.[1], Jain N.[1], Mishra S.V.[1], Sehgal V. K.[2], Pathak H.[1]

[1]*Centre for Environment Science and Climate Resilient Agriculture (CESCRA), IARI, New Delhi-110012, India*

[2]*Division of Agricultural Physics, IARI, New Delhi-110012, India*

The seasonal variability in fluxes of methane (CH_4) and carbon dioxide (CO_2) and heat fluxes were estimated using the eddy covariance (EC) technique during the wet season (kharif season) of 2013 in rice grown under alternate wetting and drying conditions. The cumulative net ecosystem methane exchange (NEME) during rice crop growth period was 3.84 g CH_4 m^2. Highest methane flux was observed between maximum tillering (MT) to panicle initiation stage at 1.86 g CH_4 m^2 and lowest flux was observed between heading to ripening stage at 0.04 g CH_4 m^2. Post ripening stage methane uptake was observed at - 0.7 g CH_4 m^2. The daily carbon dioxide (CO_2) flux fluctuated between ±0.05 g C m^{-2} d^{-1} during the early vegetative stage. Thereafter there was an uptake of CO_2 from late July until end of September which was due to sequestration of CO_2 by the plant biomass. It was observed to be highest with an uptake rate of -6.54 g C m-^{2} d^{-1} during booting stage. The cumulative net ecosystem carbon dioxide exchange (NEE) over the rice growth period was -316.6 g C m^{-2}. The average gross primary productivity (GPP) over the growing period was 7.23 g C m^{-2} d^{-1}. The rate of evapotranspiration varied from 1.4-2.5 mm d^{-1} during the different growth stages of rice. The sensible heat flux and soil heat flux (5cm) varied from -29.4 to 10.1 W m^{-2} and -3.7 to 0.64 W m^{-2} respectively. This short-term data showed significant differences in NEME and NEE during different growth stages of rice, however more investigations are required to assess the seasonal and inter-annual variability.

58. Are tree plantations climate-smart? The case of rubber tree plantations and the natural rubber commodity chain

Gay F.[1], Angthong S.[2], Bessou C.[3], Bottier C.[4], Brauman A.[5], Chambon B.[3], Chantuma P.[6], Gohet E.[3], Lacote R.[3], Liengprayoon S.[7], Poonpipope K.[8], Thaler P.[1], Thanisawanyangkura S.[9], Vaysse L.[4], Winsunthorn S.[10], Sainte-Beuve J.[4]

[1]*CIRAD, UMR Eco&Sols, 34060, Montpellier, France*

[2]*ORRAF, 10700, Bangkok, Thaïland*

[3]*CIRAD, UPR Performances des systèmes de pérenne, 34398, Montpellier, France*

[4]*CIRAD, UMR IATE, 34060, Montpellier, France*

[5]*IRD, UMR Eco&Sols, Montpellier, France*

[6]*DOA, RRIT, 10900, Bangkok, Thailand*

[7]*Kasetsart University, Faculty of Agro-Industry, 10900, Bangkok, Thailand*

[8]*Kasetsart University, Faculty of Agriculture, 10900, Bangkok, Thailand*

[9]*Kasetsart University, Faculty of Science, 10900, Bangkok, Thailand*

[10]*PSU, Faculty of Science and Industrial Technology, 84000, Surat Thani, Thailand*

Industrial tree crop plantations often enter in direct competition for land with forests. In those cases, the net result on climate is detrimental. In other cases, the possibility for tree crops to fulfil the objectives of CSA deserves a deeper investigation. This study analyses the case of natural rubber production in Thailand. The natural rubber (NR) commodity chain presents two promising features to reach CSA objectives. First, family farms represent the majority of surface areas under rubber plantations. These production systems may contribute to local sustainable development and food security. Second, NR is a natural competitor of synthetic rubber (SR) made from crude oil. Substituting SR by NR may hence allow for reductions in GHG emissions from fossil sources. We developed a multi-disciplinary research project with these two features as a backbone. The goal was to improve the productivity and the sustainability of rubber smallholdings, while making sure that their NR output would suit for SR substitution particularly in terms of consistency. Results showed a high diversity of farm structures and agricultural practices in rubber smallholdings. The diversification of farm activities, of income source and latex harvesting methods appeared to be important adjustment variables to cope with uncertainties linked to price fluctuations and natural hazards. The impact of clone, latex harvesting and post-harvesting practices on the physico-chemical properties of NR was assessed. Results also showed how rubber plantations could improve the soil ecosystem services and particularly the soil carbon content when rubber trees were planted on lands previously used for intensive annual crops. The next step of the research project is to integrate these results into a multi-criteria analysis, such as Life Cycle Assessment, in order to design and assess adaptation strategies of the NR supply chains to global changes.

This project was conducted under the umbrella of the Hevea Research Platform in Partnership (HRPP) and with the financial support of the Thai International Cooperation and development Agency (TICA).

59. Potential integrated agricultural technologies for climate-smart villages of Southeast Asia

Campilan Dindo

International Center for Tropical Agriculture - Asia Region, c/o Agricultural Genetics Institute, Pham Van Dong, Tu Liem District, Hanoi, Vietnam

In Southeast Asia, climate-smart villages (CSVs) have been established as action learning platforms for building livelihood resilience of farming communities to extreme weather events, seasonal shifts and related climate change risks. The 6 CSVs in the region comprise: 1) Northwest Vietnam upland crop-livestock systems, 2) North-Central Vietnam agroforestry systems, 3) South-Mekong Delta Vietnam rice-aquaculture systems, 4) Northwest Cambodia lowland rice-fish systems, 5) Central Lao PDR lowland diversified cropping systems, and 6) Southern Lao PDR lowland rice-based systems. This paper presents initial results in assessing potential climate-smart agriculture (CSA) options to enhance adaptive capacity among farmers and stakeholders in these CSVs. It addresses the following key questions: 1) What are the key social-biophysical constraints and opportunities for CSA adoption in CSVs? 2) How can participatory multi-stakeholder learning strategies help enhance men and women farmers' capacities for testing and adopting CSA options in CSVs? 3) What CSVs-relevant integrated technologies and practices are more effectively introduced within a farm/village-to-landscape setting? 4) What location-specific integrated technologies and practices could complement social, institutional and policy innovations within the CSVs framework? This paper is based on a CCAFS-supported project jointly implemented by 7 CGIAR Centers, led by the International Center for Tropical Agriculture (CIAT).

60. Enhancing productivity and livelihoods among smallholder irrigators through Biochar and fertilizer amendments

Macedo, Jenkins[1], Souvanhnachit, M.[2], Rattanavong, S.[3], Maokhamphiou, B.[4], Sotoukee, T.[4], Pavelic, P.[4], Sarkis, M.[1], Downs, T.[1]

[1]*Department of International Development, Community, and Environment, Clark University, Worcester, MA. USA*

[2]*Department of Water Resources Engineering, National University of Laos, Vientiane, Lao PDR*

[3]*Independent Consultant, Washington DC, USA*

[4]*International Water Management Institute Vientiane, Lao PDR*

Climate change and climate variability pose significant risks to smallholders in the rainfed lowlands of Lao PDR. Increased surface temperatures, declining rainfall, persistent drought and depletion of soil nutrients all serve to impact agricultural productivity and livelihoods. This study investigates the impact of five treatments on soil nutrients, moisture, plant growth, and yield of water spinach (Ipomoea aquatica). The treatments tested were rice husk biochar only, biochar inoculated with manure, manure tea, inorganic fertilizer and the control. The costs and benefits of the treatments were also assessed. The randomized complete block design was used to assign five treatments and eight replications to the experimental units. Biochar was produced through slow pyrolysis. Soil physical properties were assessed with the visual soil assessment method and 15-randomized soil samples were collected for chemical analyses. Sprinklers were used for irrigation and a weather station installed to monitor the climate. Descriptive statistics and analysis of variance were used to analyze the data. Costs-benefits evaluation of the treatments was conducted to determine the net benefits relative to the initial costs ratio. The analysis of variance of mean yield indicates that the difference in yield among the treatments was highly significant. The computed F value (8.08) was higher than the tabular F value (4.07) at the 1% level of significance. The calculated coefficient of variance of mean yield was 17.33%. The net benefits to initial costs ratio of treatments suggest that the control (5.84), biochar inoculated with manure plus NPK (0.93), and biochar plus manure (0.87) are preferred. The net benefits and initial costs evaluation of treatments is important to assess whether utilizing these treatments would impact smallholders' livelihoods. The results of this study contribute to the evidence that biochar could play an essential role to mitigate climate change risks by enhancing soil quality and increase agricultural productivity.

61. Climate change and agriculture in India

Jha Anil Kumar

Govt. Girls P.G. College, Morar, (Jiwaji University), Gwalior, Madhya Pradesh, India

This paper assesses the impact of climate change on Indian agriculture covering a cross section of crops, seasons and regions based on existing literature. The study notes that the impact of climate change will vary across crops, regions and climate change scenarios. The evidences indicate a decrease in production of crops in different parts of India with an increase in temperature. A number of studies indicate a probability of 10 % to 40% loss in crop production in India with increases in temperature by 2080-2100. In areas located above 27° N latitude yields of irrigated and rain fed wheat are projected to rise in response to climate change whereas in all other locations yields are projected to decline by -2.3% to -23.9 %. Temperature rises of between 2° C to 3.5 ° C are projected to lead to a loss of 3-26 % in net agricultural revenues. This paper further argues that increasing climate sensitivity of Indian agriculture will lead to greater instability of India's food production which will also impact on poverty and livelihoods. How quickly Indian farmers are able to adjust their farming practices to adapt to climate change, and what policies or technologies will enable rapid adaptation to climate change are issues that merit attention.

62. A suitability assessment for "alternate wetting and drying": targeting priority areas for mitigation in rice production

Sander Bjoern Ole[1], Wassmann Reiner[1], Nelson Andrew[1], Palao Leo[1], Wollenberg Eva[2]

[1]*International Rice Research Institute (IRRI), Los Baños, Philippines*

[2]*University of Vermont, Burlington, Vermont, USA*

The water-saving technology "alternate wetting and drying" (AWD) for rice production has been developed by the International Rice Research Institute and its partners more than 10 years ago. Since then the practice that saves 15-30% of irrigation water has been implemented in various rice producing regions in Asia. In recent years, however, the greenhouse gas mitigation potential of AWD has become more and more relevant for policy makers as the main reason to implement this technology. AWD can reduce methane emissions from rice fields by up to 70% without compromising yield. The Paddy Rice Component of the Climate and Clean Air Coalition (CCAC) aims to disseminate AWD on large scale in Vietnam, Bangladesh and Colombia by supporting policy makers with targeted information and implementation road maps. One key activity of this component is a GIS-based suitability analysis for AWD in order to identify high-priority areas for the technology. The analysis estimates the area and locations that are climatically suitable for AWD taking into account climate and soil data. The basic assumption of this suitability assessment is that the ability to drain a rice field will depend on the actual water balance, *i.e.* if rainfall is higher or lower than water loss. The main result of this assessment are suitability maps for different countries and different cropping seasons. Suitability in these maps is described in three levels - low, medium and high – according to the extent of water deficit during the rice growing season. This analysis is the first attempt to map the suitability of AWD which is very important for policy makers in rice producing countries in order to effectively implement AWD. Furthermore, this assessment reveals the potential of AWD as well as its limitations. I will introduce the CCAC Paddy Rice Component and explain the details of our biophysical suitability assessment.

L1.3 Latin America

63. Learning to face the challenges posed by climate change to Andean agriculture: teaching the farmers of the future

Quiroz Roberto, Valdivia Roberto, Turin Cecilia, León-Velarde Carlos, Mares Victor

International Potato Center (CIP), Lima 12, Lima, Peru

Climate change affects the livelihoods of rural families in areas of traditional agriculture. The Andean High Plateau is one of the centers of origin of climate smart agriculture as farmers have successfully dealt with climate variability and risk for centuries, creating a highly complex and well adapted agriculture. However, land fragmentation, population growth, limited access to credit and markets, inadequate rural education and the increased occurrence of extreme weather events, are contributing to a scenario of stagnant agriculture, pervasive poverty, food insecurity and malnutrition. Novel approaches are required to re-establish climate smart agriculture. Traditional and scientific knowledge should be used to enable school children, who are the farmers of the future, to adapt to climate change. CIP and its partners have worked in the improvement of farming systems in which components such as potato, quinoa, dairy livestock, alpacas, greenhouse vegetables and non-agricultural activities such as trout farming and handicrafts contributed to income generation, food security and child nutrition. The extreme importance of involving school children in the participatory work was recognized. CIP´s work involved the participation of 693 male and female school students. The entry point for interventions was the nutritional status of children since an evaluation showed the prevalence of chronic malnutrition. Options to improve the diet of children and their families were implemented. A central activity was the production of vegetables in school and family greenhouses and the training in nutritional issues for the use of local foods combined with the vegetables. Nutritional training was complemented with information on conservation of native potatoes biodiversity, soil conservation, potato seed propagation, composting, crop rotations and reforestation. We intend to support this approach with novel educational tools, to create a cadre of new farmers that complement traditional knowledge with scientific knowledge for the development of climate smart agriculture in the Andes.

64. Comparison between a Tier 3 and Tier 2 approach to estimate enteric methane emission in Brazilian beef cattle

Bannink André[1], Geraldo de Lima Jacqueline[2], Van Den Pol-Van Dasselaar Agnes[1], Menezes Santos Patricia[3], Resende Siqueira Gustavo[4], Barioni Luis[5]

[1]*Wageningen UR Livestock Research, PO Box, 65, 8200 A Lelystad, Netherlands*

[2]*University of São Paulo, Avenida Pádua Dias, 11, 13418-900, Piracicaba, Brazil*

[3]*Embrapa Southeast Livestock, Rodovia Washington Luiz, km 234, 13560-970 São Carlos, Brazil*

[4]*São Paulo Agency of Agribusiness Technology, Rui Barbosa avenue, 35, 14.770-000, Colina, São Paulo, Brazil*

[5]*Embrapa Informática Agropecuária, Avenida André Tosello, n209, Barão Geraldo, 60411-308, Campinas, Brazil*

Brazilian inventory of enteric CH_4 emission is currently based on the IPCC Tier 2 approach. Although IPCC recommends the use of a more specific Tier 3 approach, this is hampered by a lack of consolidated data for the development, evaluation and application of such a Tier 3 approach. The purpose of this study was to compare a dynamic, mechanistic model of enteric fermentation currently used as a Tier 3 approach in the Dutch GHG inventory for dairy cattle with the Tier 2 approach used in current Brazilian GHG inventory for beef cattle production systems. Six systems were characterized which differ in the type and level of dietary supplementation, leading to a range in period till slaughter of 14 to 44 months. Diet supplementation and reduction of the period till slaughter resulted in a three to fourfold decrease in CH_4 emission from cumulated DMI till slaughter, and per kg average daily gain and kg of beef carcass produced. The higher the supplementation of the diet, the lower CH_4 emission intensity and the lower the estimated CH_4 conversion factor Ym (fraction of gross energy intake emitted as CH_4). Predicted Ym was, averaged over all seasons and production systems, 20% lower (0.052) than the 0.065 default in the Tier 2 approach. The present results suggest there is scope for an alternative to the Tier 2 approach, and that refinements in Ym dependent on the specific production conditions can be made. Applicability of the present results has to be explored further, however, with emphasis on rumen degradation characteristics and diet digestibility, and on the rumen fermentation profile (profile of volatile fatty acids and associated methane produced by rumen micro-organisms).

Funding by EU-FP7 AnimalChange (Grant Agreement 266018), Dutch Ministry of Economic Affairs (KB-12-006.04-003) and Capes (Cordenação de Aperfeiçoamento de Pessoal de Nível Superior) is gratefully acknowledged.

65. Effect of climate variability and climate change in the agricultural sector of Panama.

Martiz Graciela

Ministry of Agricultural Development, Environmental Unit, Panama

The Panamanian agricultural sector is highly vulnerable to climate variability and climate change causing significant changes in precipitation, leading to prolonged periods of drought, the occurrence of pests, crop diseases, and diseases in animals which seriously affect food production. The most vulnerable areas to this climate condition are in the provinces of Cocle, Herrera, Los Santos, Veraguas and Ngâbe Bugle Comarca (National Environmental Authority, 2011). The province of Panama is also affected, it experienced frequent water shortages.

Between the years of 2013 through 2014, the loss due to climate change was estimated to be about 56 million dollars. The crops most impacted were rice, maize, beans and bananas which are staples and are food security for the country. Changes recorded in planting areas, where a crop is replaced by another, have affected the farmers who have to adopt new agricultural production techniques, especially to optimize the use of water resources.

The quality and availability of pasture along with water shortages has increased the loss of livestock and minimized their production. This affects 37.6% of the total population of those who live in Panama's rural areas (Contraloria General of Panama, 2010).

66. Adaptation of small coffee producers to climate change in Nicaragua

Sepúlveda Norvin

CATIE, Km 8 carretera a Masaya (MAGFOR), codigo 10000, Managua, Nicaragua

In Nicaragua, coffee production is a very important part of the economy and society, being one of the most important sources of income for small producer's families; it also contributes significantly to national agriculture (coffee represents 20%-25% of export revenues in Nicaragua and Honduras, two of Latin America's poorest countries). According to Laderach, *et al*, climate forecasts predict severe impacts of climate change. Climate models and crop-niche suitability predictors show considerable changes in both the quality of coffee beans and the altitudinal zones suitable for production.
CATIE in a strategic alliance (CONACAFE, CIAT and UNA) built a collaborative network that shares knowledge and efforts, to strengthen adaptive capacity especially of small coffee producers. Through participative workshops in all the coffee production regions in Nicaragua, perceptions of the impact of climatic change and specific strategic for mitigation and adaptation to small producer were reviewed, then in a national workshop the strategies were validated and improved, finishing with a national strategy of coffee adaptation to climatic change.
The most important strategies selections were: - diversification in the short term and complete crop substitution in the long term for fruit trees, cocoa and others varieties of coffee which are more suitable for the projected climatic conditions, - honey production, flower production (especially orchid) have been one alternative with income higher than the coffee income, - water and soil conservation which increases the resilience of the crop to plant diseases. Finally the producer considered that ecosystem services payments scheme seems to be a strategy which synergizes emissions mitigation, biosphere preservation, and poverty alleviation. The promotion of biological corridors, and reforestation could slow down and reduce fragmentation or forest, while providing ecosystems services as a strategy for mitigation and adaptation at the same time.
In conclusion, the national strategy is considered as an opportunity to develop a climate-smart agriculture (focus in coffee production), taking in consideration the climatic change and the suitability of the crop in the future.

67. Can CO_2 fertilization compensate for progressive climate change impacts on coffee productivity?

Ovalle-Rivera Oriana[1], Van Oijen, Marcel[2], Läderach Peter[3], Roupsard Olivier[4], Rapidel Bruno[5]

[1]*CATIE, Division de Posgrado, 7170, Turrialba, Costa Rica*

[2]*CEH, Edinburgh, United Kingdom*

[3]*CIAT, Managua, Nicaragua*

[4]*CIRAD, UMR Eco&Sols, Montpellier, France, and CATIE, DID-PAAS, Turrialba, Costa Rica*

[5]*CIRAD, UMR SYSTEM; Montpellier, France, and CATIE, DID-PAAS, Turrialba, Costa Rica*

Different studies report negative impacts of climate change on coffee productivity using simple crop models. These models do not predict the effect of complex interactions between changing weather variables, like CO_2, temperature and rainfall, and their consequences on plant physiology. In this study, a coffee agroforestry process based model (CAF2007) was used to integrate processes and mechanisms that determine climate change effects on coffee. The model was calibrated using data of 11 experimental plots in different agro-climatic and managements conditions, using Bayesian calibration methods. We validated the model in commercial coffee plantations and finally used it to estimate climate change impacts and simulated shade tree management to explore adaptation options.
Bayesian calibration greatly improved the performances of the model. The RMSE were generally lower when calibrating independently on the 11 experiments, but the agreement was still good when the calibration was made in all experiments within one climatic zone, or even globally using all 11 datasets. The model calibrated globally was more robust. It performed adequately when using data from commercial farms located in all four climatic regions that form the coffee producing regions of Costa Rica and Nicaragua.
Annual average precipitation changes (predictions from RCP8.5 emission scenario and downscaled MIROC5 GCM) affect coffee yields both positively and negatively depending on site conditions and magnitude of change; temperature increases affect coffee yield negatively. However impacts depend on shade tree density and species. CO_2 fertilization affects coffee positively, and can compensate for negative effects of temperature and precipitation changes.
Shade from densely planted timber trees was more effective than heavily managed shade from Erythrina poeppigiana in mitigating the negative effects of temperature increase on coffee.
We discussed other adaptation strategies to adapt coffee agroforesty systems to climate change, as well as increase their CO_2 sequestration.

68. Agricultural practices, agroecological integrated farms and sustainable indigenous territorial development in Honduras

Juan Medina[1], Edwin Torres[2]

[1]*CATIE, The Tropical Agricultural Research and Higher Education Center, Tegucigalpa, Honduras*

[2]*FUNACH, Action Aid Foundation Honduras. Victoria, Yoro, Honduras*

Most small farmers in rural production landscapes are distributed in communities in indigenous territory Toulupan, whose main source of income is small-scale cultivation of coffee, basic grains and selling their labor, and does not generate enough income to cover their basic needs and food security.
An investigative process was conducted - with participatory focus group and key informant interviews to verify the contribution, functionality and sustainability of 9 integrated farms for food security, and also the solidarity link between farms and in rural communities. Teaching experiences are systematized - collective learning in 2 field schools (ECA), analyzing the implementation of sustainable integrated farms, changes identified in 40 families that participated during 2 years in the field schools.
The results show that families perceive the reduction of vulnerability of families at risk, and form communities resilient to effects climate change through their participation in local platforms, have better food quality and variety in their homes and communities, meaning through crop diversification in their integrated farms, by changing from traditional practices to sustainable practices that increase vegetative cover. Also crop diversification has allowed them to increase their production surplus, to market and increase their family income by 15% by selling products from their farms relative to the baseline (US $ 1 to 1,19 per capita).
The successful experiences of this exchange of knowledge among family members, group members and communities, linked to farm planning, reflects key processes for sustainability of rural production landscapes for making better decisions for conservation of these territories faced with the effects of climate change.

69. Methane emission efficiency as a function of grazing management in Southern Brazilian grazing systems

Savian Jean V.[1], Cezimbra Ian M.[1], Filho William S.[1], Bonnet Olivier J.F.[1], Neto Armindo B.[14], Schons Radael M.T.[1], Tischler Marcelo R.[1], Nunes Pedro A.A.[1], Almeida Gleice M.[1], Araújo Bárbara[1], Barro Raquel[1], Genro Teresa C.M.[2], Berndt Alexandre[2], Barioni Luis G.[2], Bayer Cimelio[1], Carvalho Paulo C.F.[1]

[1]*Grazing Ecology Research Group, Faculty of Agronomy, Federal University of Rio Grande do Sul, 91501-970, Porto Alegre, Brazil*

[2]*Brazilian Agricultural Research Corporation (EMBRAPA), Brazil*

Ruminant livestock production is an expanding sector in Brazil and accounts for more than 70% of the national methane (CH_4) emission. As most of the livestock is raised on pastures, grazing management is the pivotal factor affecting animal production and CH_4 emission efficiency. However, actual mitigation potential of grazing management on enteric CH_4 emission is poorly documented. We report here the results from various grazing experiments conducted in South Brazil between 2011 and 2014 on the relationships between grazing management, vegetation structure and quality, grazing behaviour, enteric methane emission and animal production. In native grassland, heifers continuously stocked on moderate grazing intensity (herbage allowance of 3 kg DM / kg LW) resulted in highest live weight (LW) gain per individual and per unit area basis, as well as high CH_4 emission per individuals. However, CH_4 emission efficiency was improved as CH_4 emissions per kg of LW gain was minimized (0.8 kg CH_4 / kg LW gain). In integrated crop-livestock systems (ICLS) with steers continuously stocked on black oat/Italian ryegrass pastures, the moderate grazing intensity maximized LW gain and optimized CH_4 emission efficiency. In another ICLS trial, lambs continuously stocked resulted in better CH_4 emissions efficiency than rotational stocking, mainly because animals had opportunity to select a better diet. However, an experiment contrasting rotational stocking strategies showed good results when moderate grazing intensity was assured by pre and post grazing sward targets based on intake rate maximization and flexible stocking cycles. In all experiments the relationship between CH_4 emissions and dry matter intake was significant, but weak ($R2 < 0.25$), pointing out other explaining factors such as forage digestibility and inter-individual variations. These sets of results indicate that despite grazing systems types, moderate grazing is essential to optimize enteric methane emission efficiency.

Acknowledgement: The research leading to these results has been conducted as part of the AnimalChange project which received funding from the European Community's Seventh Framework Programme (FP7/ 2007-2013) under the grant agreement n° 266018.

70. Technological options to increase resilience of production systems to extreme climate events

Bolaños Benavides Martha Marina., Ospina P. Carlos Eduardo, Rodríguez B. Gonzalo Alfredo, Martínez M. Juan Carlos, Galindo P. Julio Ricardo, Ayarza Miguel.

Corporación Colombiana de Investigación Agropecuaria CORPOICA, Colombia

The increasing incidence and intensity of extreme climate events in Colombia (sudden droughts and floodings) has stimulated research and development institutions to develop technological responses to reduce vulnerability of production systems. The Colombian agricultural research Institution, CORPOICA is leading since 2013 a multi-institutional and multi-disciplinary project to identify and asses the biological and economic efficiency of management options to increase resilience of 54 production systems in regions that were affected by la Niña in 2010-2011. Researchers have characterized the biophysical and socioeconomical constraints in 43 production systems at farm level and have captured local perception on climate hazards and adaptation responses through 1416 surveys. At the same time, more than 900 documents related to soil and water management options, improved germplasm and integrated pest management strategies with potential to reduce vulnerability and improve economic efficiency have been collected. Most annual crops, especially vegetables and some perennials like plantains, are very sensitive to water excess/deficits while others like cassava and pasture species are more sensitive to water excess. Most promising management options to improve adaptation have been selected in participatory workshops as a function climate risks, socioeconomic conditions of farmers and available technologies. These best-bet options are under validation in pilot sites where local land technical knowledge meet to develop integrated agro climatic management plans to strength the capacity of local extension services and small farmers to plan and implement adaptation responses.

Acknowledgements: Fondo Adaptación for financial support to carry out project activities

71. Supporting dairy family farmers of Pernambuco state (Brazil) to develop a climate-smart agriculture

Fages Marjolaine[1], Le Guen Roger[1], Côrtes Cristiano[2], Silva de Melo Airon Aparecido[3]

[1]*Groupe ESA, Laboratoire LARESS, 49 007, Angers, France*

[2]*Groupe ESA, Laboratoire URSE, 49 007, Angers, France*

[3]*Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Garanhuns, CEP 55292-270, Garanhuns/PE, Brazil*

Milk production in Pernambuco is located in the southern rural region of the state, a semi-arid area in process of desertification where most of the farms are family-owned. These have been strongly affected by exceptional droughts in 2012 and 2013. In collaboration with the Federal Rural University of Pernambuco, 21 group interviews involving 276 milk producers and their families, and 46 individual interviews with professionals in the dairy sector have been made. Their purpose was to study ways of supporting family farms to be more productive and more resilient to climate change. Lack of advice is the first difficulty cited by farmers to develop their production system: only 7% of producers surveyed received a visit from a technician last year. All farmers would like a professional who will meet them on their farms and 72% of them say they are quite willing to follow his recommendations. Professionals explained the inefficiency of the service for rural development by the lack of staff (57%) and lack of skills (47%), the poor implementation of public policies (30%), the bad working conditions (26%) and the interference or, conversely, the disinterest of politicians (20%). More than half of professionals believe that the counseling and rural development service should be carried out by state agencies and 20% of them believe that it is important to form partnerships among government agencies, private companies and producer organizations. This requires the creation of opportunities for dialogue between the various stakeholders to agree on the organization and financing of an efficient support service in the field, enabling farmers to maintain their activity in the region.

72. Energy efficiency of beef cow herds with different calving season in the south-east of Buenos Aires province, Argentina

Ricci Patricia[1], Aello, Mario S.[2], Arroquy José Ignacio[3], Rearte Daniel[4]

[1]*Instituto Nacional de Tecnología Agropecuaria (INTA), Animal Nutrition Group, 7620, Balcarce, Argentina*

[2]*Universidad Nacional de Mar del Plata, Facultad de Ciencias Agrarias, Animal Nutrition Group, 7620, Balcarce, Argentina*

[3]*CITSE- CONICET, FAyA-UNSE, and INTA, 4200, Animal Production Group, Santiago del Estero, Argentina*

[4]*Labintex, Agropolis International, F-34394, Montpelier, France*

The aim of the study was to evaluate the energy efficiency of two beef cow herds with either autumn (AC, n=40) or winter calving season (WC, n=32), as gross energy intake (GEI) and methane (CH_4) loss per kg of weaned calf. Energy requirements were estimated (NRC, 2000) from Aberdeen Angus cross Hereford cows (55 ± 14 months old) that continuously grazed Tynopirum ponticum and Festuca Arundinacea dominated pasture during 1 year in the in the south-east of Buenos Aires province, Argentina. Calves were weaned at 7 (AC) and 6 (WC) months old. Cow-calf body weight (BW) were registered over the year. Results were analyzed with MIXED procedure of SAS with calving season as factor. Annual GEI of AC was greater than WC cows (72 ± 4 vs. 58 ± 5 $GJ.yr^{-1}$; $P < 0.001$). However, AC calves were heavier than WC at weaning (200 ± 23 vs. 141 ± 22 kg; $P < 0.001$). The energy cost per kg of weaned calf was 14% greater in WC than AC cows. Methane per kg of weaned calf of AC was lower than WC cows (426 ± 41 vs. 486 ± 68 g $CH_4.kg\ calf^{-1}.yr^{-1}$; $P < 0.001$). The greater CH_4 emitted by AC cows is counteracted by a higher performance of their calves, thus the energy efficiency was higher for AC than WC herds. The AC cows can have a longer lactation ending in spring, hence obtaining heavier calves at weaning. The AC could be suggested as a management alternative to reduce CH_4 emission intensities and contribute to improving the efficiency of finishing period by obtaining a heavier calf at weaning. More studies are needed at a bigger scale to analyze interactions of this calving season alternative with other components of the system.

73. Does diversification in smallholder coffee landscapes help to face climate change risk? Answers from Nicaragua

van Zonneveld, Maarten[1], Gonzalez Daysi[2], Guevara Ramon[3], Fallot Abigail[4]

[1]*Bioversity International, CATIE 7170 Turrialba, Costa Rica*

[2]*Research Platform on Production and Conservation in Partnership (RP-PCP), CATIE 7170, Turrialba, Costa Rica*

[3]*Independent consultant, Managua, Nicaragua*

[4]*Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), CATIE 7170 Turrialba, Costa Rica*

Introduction: Despite the growing emphasis on diversification to manage climate change risks and improve food security in coffee landscapes, there are no criteria developed to quantify the status, need and outreach of diversification.
Objectives: We aim to identify with local stakeholders: 1) different dimensions of on-farm diversification including crops, products, markets and practices; 2) its relationship with climate risk management; and 3) the need for specific measures to make use of the potential of diversification to make coffee landscapes resilient to climate change.
Methods: We carried out a literature review highlighting the benefits and drawbacks of diversification for smallholders of coffee landscapes. Institutions and focal groups from two communities in San Ramon, Nicaragua were consulted about existing diversity in coffee farms and what on-farm diversification would represent for them. Taking into account gender, we conducted interviews in farm households to understand how actual diversification is related to climate risk management and food security status, and to identify specific needs to make use of the potential for diversification.
Results and discussion: Though a large diversity of agricultural species is grown in the landscape, most on-farm activities are concentrated around coffee, maize and common beans and take place between May and August, which coincide with the months of seasonal hunger. This suggests a high potential for diversification which is currently little utilized to improve food security and to adapt production system to climate variability. We highlight which activities related to diversification are recommended to make coffee landscapes more resilient to climate change. To embed our results in local development processes and local research we linked up to existing initiatives Campesino a Campesino and the local university agronomy faculty.

Acknowledgements: This study is financed by the PCP Research Platform and CCAFS.

74. Ensuring climate smart agriculture is gender-smart: lessons from Latin America

Twyman Jennifer[1], Bernier Quinn[2], Muriel Juliana[1], Paz Liliana[3], Ortega Luis[3]

[1]*Centro Internacional de Agricultura Tropical (CIAT), KM 17 Recta Cali-Palmira, Cali, Colombia*
[2]*International Food Policy Research Institute, 2033 K St, NW, Washington, DC 20006-1002, USA*
[3]*EcoHabitats, Popayan, Colombia*

This paper uses qualitative and quantitative data to examine the gender implications of a community-based adaptation process being implemented in rural communities of Colombia. The primary objective of the paper is to identify key factors contributing to reducing gender inequalities and/or empowering women through the process of participatory local adaptation planning. In Colombia, communities are working with research and development partners to create local adaptation plans with a gender focus by choosing climate smart agricultural practices that they believe will help them adapt to climate change. This paper explores the tools and methods used to raise awareness about key gender inequalities such as the gender division of labor, time allocation/poverty, access to resources and participation in decision-making. It then discusses the community's perceptions and responses to such gender information in the context of local adaptation planning. This qualitative data reflecting on the participatory approach is complemented by quantitative data regarding gender differences in 1) perceptions of climate change and/or climate variability, 2) awareness and adoption of CSA practices, and 3) access to and use of agro-climatic information. This information was collected in the CCAFS site of Cauca, Colombia using the CCAFS gender survey, an intra-household survey, which collected information from both a man and woman decision-maker in 200 households in the site. The quantitative data will be used to verify and explain qualitative data as well as to inform participatory processes with communities. The analysis of both the qualitative and quantitative data will identify the key factors for successfully including gender in local adaptation planning as well as recommendations for strengthening gender inclusion and scaling out the process.

75. Do local perceptions converge to climatological data? Case studies in three Brazilian biomes

Litre Gabriela[1], Nasuti Stephanie[1], Lindoso Diego[1], Saito Carlos[1], Henke Carlos[1], Da Silva Carolina Joana[2], Eiro Flavio[3]

[1]*Centro de Desenvolvimento Sustentável - CDS, Campus Universitário Darcy Ribeiro - Gleba A - Asa Norte – Brasília-DF, CEP 70.904-970, Brazil*

[2]*Universidade do Estado de Mato Grosso, Av. Tancredo Neves, 1095 - Cavalhada II, 78200-000 - Cáceres - Mato Grosso, Brazil*

[3]*ERIS-CMH, 48 bd Jourdan, 75014 Paris, France*

Climatological data has shown a steady increase of temperature levels in all Brazilian regions over the last 50 years. On the other hand, rainfall levels records have remained stable in many areas of the country. This is the case of several areas of the Mato Grosso (MT) state of Brazil, the second largest producer of agricultural products such as soybean, and sugarcane, and one of the most threatened by climate change. Approximately 70% of the surveyed areas of MT, including the Chapada dos Guimaraes in the Cerrado biome, have revealed stable rainfall levels between 1980 and 2010.

The present research, carried on by the Universities of Brasilia (UnB) and Mato Grosso (UNEMAT) through the subnetwork Regional Development and Climate Change of the Brazilian Network for Climate Change Research (Rede CLIMA/INPE) aims to compare rainfall records from meteorological stations along-with the rainfall perceptions of 398 family farmers from different municipalities in Mato Grosso (Matupá, in the Amazon biome; Agua Boa and Chapada dos Guimaraes, in the Cerrado biome, and Barão de Melgaço, in the Pantanal biome).

Through the comparison of climate change perceptions of family farmers from two groups of municipalities - those with an effective decrease of rainfall levels and those with stable rainfall levels within the last three decades - this study concluded that the majority of the interviewed farmers from Amazonia, Cerrado and Pantanal biomes equally attributed the loss of agricultural productivity to a decrease of rainfall levels, even when rain records had remained stable.

A preliminary analysis suggests that many family farmers from the three biomes wrongly attribute the loss of their agricultural productivity to a decrease in rainfall levels when, in fact, their economic loss is rooted in other climatic factors such as: i) an increase in dry spells or "veranicos "(measurable through the number of consecutive dry days in the rainy season), ii) a change in the distribution and frequency of rainfall throughout the year, iv) an increase of temperatures levels (in cases confirmed by climatological data), and v) an increase in evapotranspiration levels along with an increase of water stress levels leading to alterations in the water balance necessary for a proper crop development. Preliminary results also indicate that the loss of agricultural productivity could be attributed to a displacement of the start and/of duration of the rainy season in each of the three biomes. We conclude that the study of the alterations of dry spells and water balance should be improved to better understand the loss of agricultural productivity in a context of climatic change. Also, researches about misperceptions and cultural influences on environmental analysis and on the comprehension of the environmental processes, related to scientific literacy and environmental education fields, should be stimulated in the search for the improvement of community resilience to ever-changing world.

76. Does carbon storage of pastures contribute to a climate smart cattle farming after Amazonian deforestation?

Blanfort Vincent[1], Stahl Clément[1,2], Fontaine Sébastien[3], Picon-Cochard Catherine[3], Freycon Vincent[4], Blanc Lilian[4], Bonal Damien[5], Soussana Jean-François[3], Lecomte Philippe[1], Klumpp Katja[3]

[1]*CIRAD, UMR 112 Tropical and Mediterranean Animal Production Systems, Campus international de Baillarguet, 34398 Montpellier, France*

[2]*INRA, UMR 0745 Ecofog, Campus agronomique, 97379 Kourou, France*

[3]*INRA, UR 874, Grassland Ecosystem Research Team, 63100 Clermont-Ferrand, France*

[4]*CIRAD, UR 105 "Biens et services des écosystèmes forestiers tropicaux", 34398 Montpellier, France*

[5]*INRA, UMR 1137 EEF, 54280 Champenoux, France*

More than 15% of Amazon forest has been converted to pastures these last decades. Some authors argued the world's permanent pastures (30 % of total land) could potentially offset up to 4% of the global GHG emissions, having a carbon (C) storage potential equal to 0.5 Mg $C.ha^{-1}.yr^{-1}$(Schulze et al 2009). Accordingly, pastures are good candidates to increase soil uptake C in soil while ensuring a basic food production. Here we would like to assess the effects of tropical forest conversion to cattle pasture in the French Amazonia (French Guiana), by following the long-term dynamics of soil C stocks of permanent tropical pastures (Brachiaria humidicola) after deforestation from 1970. A soil inventory campaign was performed to analyse soil C and N stocks (to 1 m depth) along a pasture chronosequence of 6 months to 36 years old pastures and 4 native forest sites (total 24 sites). The annual C sequestration potential demonstrated by the chronosequence, was compared with eddy covariance flux measurements on 2 pastures and one native forest. Our study shows that old (≥ 24 years) tropical pastures resettle the recurrent C storage observed in native forest. These pastures stored between 1.8 ± 0.5 and 5.3 ± 2.1 tC ha^{-1} yr^{-1} compared with 2.6 ± 0.5 tC ha^{-1} yr^{-1} for the nearby native forest. Our finding show that old tropical pastures accumulate carbon in soil organic matter, particularly in the deep soil layers (0.2-1 m) and without loss of soil fertility. It suggests that such pastures can be exploited by farmers in the long term with appropriate practices (no fire and no overgrazing, but a mixture of grasses and legumes and a grazing rotation plan). Clearly, efforts to curb deforestation are a priority in order to preserve forest biodiversity and C stocks. But it seems now that, in a climate-smart agriculture way, the current challenge is to manage these deforested areas to maintain the productivity of agricultural ecosystems and in the same time their capacity to mitigate GES.

Acknowledgements: This study was co- funded by CIRAD, INRA, CNES, European regional development found (ERDF 2007-013) and AnimalChange project (FP7 KKBE 2010-4).

77. Socio-economic scenarios to develop and test agricultural adaptation policies in Central America and the Andes

Veeger Marieke, Vervoort Joost

University of International Cooperation (UCI), De la Rotonda El Farolito, 200m este y 150m norte, Barrio Escalante, San José, Costa Rica

Successful climate adaptation strategies cannot take only climate impacts into account. Instead, socio-economic, ecological and political factors interact with climate impacts, strongly influencing both the adaptive capacity of vulnerable groups, and their needs. A multi-stakeholder scenarios approach with multiple plausible, narrative and numerical, stories about future contexts can help policy makers work with future uncertainty that may influence adaptive capacity in their regions. However, in many scenario processes, it is not clear whether the scenarios have had an impact on decision-making. To overcome this challenge, we have found that scenarios are most powerful when they are used to test and develop specific decision pathways, such as government policies and action plans. We present two cases: Honduras and a regional Andes process where we focus on Colombian policy. The successful use of scenarios for targeted policy guidance that encourages Climate Smart Agriculture depends on developing a strong relationship with decision-makers to identify draft policies and information needs; it depends on a process where tailored scenarios are used directly to review and develop policies up to their finest details together with a multidisciplinary and multilevel team of experts and decision makers; it also requires openness and flexibility on the side of the decision-makers and the facilitating researchers to put changed policies into action.

78. Future climate change impacts on maize production in the Cerrado of Brazil

Silva Fernando Macena[1], Affholder François[2], Corbeels Marc[1,2]

[1]*Embrapa-Cerrados, 73310-970, Planaltina, DF, Brazil*

[2]*CIRAD, Agroécologie et intensification durable des cultures annuelles, 34398 Montpellier, France*

About 70% of Brazil's farm output is produced in the Cerrado region. The climate is sub-humid tropical, typical of the rather moister savanna regions of the world. Climate changes will have a severe impact on the agricultural sector in this region. A temperature increase of between 2 °C and 4 °C by the end of the century has been predicted. Model projections for future rainfall under high emission scenarios suggest a decrease of 20% to 40% of current values. The objective of this study is to assess the impact of climate change on maize yields in the Cerrado. To do so, we used the crop growth model STICS that was calibrated and tested against crop and soil data from an agronomic field trial at the experimental station of Embrapa Cerrados. The simulations covered present climate (1961-1990) and projections for the IPCC A1B emission scenario (2011-2050, 2051-2100). Climate change projections were generated using the Eta CCS regional climate model nested in the global model HadAM3P. Two systems were simulated: maize under conventional tillage and under no-tillage. We simulated water-limited yields for a typical local maize cultivar for 12 sowing dates and for two soil types, representing a scenario of low and high plant-available soil water storage capacity. STICS satisfactorily reproduced the growth and development of maize and the soil water dynamics of the experiment. Crop yields were highest under no-tillage. This cropping system uses most efficiently the seasonal rainfall as a result of reduced surface water run-off and soil evaporation, and also presents the greatest year-to-year yield stability. Future higher temperatures cause a significant decrease in the growing period of maize (an average of 20 days) leading to lower total biomass and grain production. Due to future decreased rainfall and increased risk of longer dry spells the sowing windows for optimal yields become smaller, especially under the conventional tillage system.

79. Agro-Climatic forecasting system for better decision making in Latin America

Giraldo Diana, Barrios Camilo, Arango David, Obando Diego

International Center for Tropical Agriculture (CIAT), Climate and crop modeling team in DAPA. Km 17, Recta Cali-Palmira, Valle Del Cauca, Colombia

Whilst in other regions of the world there are a range of initiatives related to agro-climatic forecasting, there is a big gap in Latin America, which provides a tremendous opportunity to contribute with a targeted and well-integrated initiative to make a step change in Agro-Climatic Risk Management, the elaboration of public policies in decision-making and programmatic support (based on historical analysis, monitoring systems and agro-climatic forecasts) using the latest approaches.
In Colombia since 2013 climate forecasts were elaborated (1 to 6 months), based on Canonical Correlation Analysis (CCA) using different predictors as sea surface temperatures, geopotential height, zonal and meridional wind, among others. Precipitation, maximum and minimum temperatures were used as predictand field with 114 meteorological stations with monthly records from 1980-2013, evaluating the degree of correlation of the predictors, the periods for which forecasts were run, and the degree of predictability associated with the predictantes. Spatial patterns were identified, associated with known sources of variability such as ENSO, El Niño Modoki, the Amazon basin, Chocó low-level jet.
This CCA tool helped us to design and implement seasonal forecasts pilots and consistent adaptive actions involving climate and crop models, giving farmers, through extension services, reliable information about: When to plant? When to harvest? Which variety to choose? Irrigated or rainfed use? Density of sowing? Through a joint effort with our partner Fedearroz (rice grower associations) using agro-climate forecast (combined climate and crop models) we were able to avoid big economic losses for about 170 rice growers on 1800 hectares thanks to farmers followed a specific recommendation: changing the planting date in Cerete-Cordoba and choosing the best variety resulted in an increase of around 2 tons/ha in Espinal-Tolima.
Under this approach, we found that factors such as climate and agronomic management are essential for productive sustainability of Colombian farmers.

80. LivestockPlus: supporting low emission development for livestock sector in Costa Rica and Colombia

Rao Idupulapati[1], Jenet Andreas[2], Tapasco Jeimar[1], Chirinda Ngonidzashe[1], Rosenstock Todd[3], Twyman Jennifer[1], Laderach Peter[1], Peters Michael[1], Arango Jacobo[1], Hyman Glenn[1], Barahona Rolando[4], Nelson Vivas[5], Camilo Plazas[6], Mauricio Chacon[7]

[1]*CIAT, Cali, Colombia*

[2]*CATIE, Turrialba, Costa Rica*

[3]*ICRAF, Nairobi, Kenya*

[4]*National University, Medellin, Colombia*

[5]*University of Cauca, Popayan, Colombia*

[6]*University of Llanos, Villavicencio, Colombia*

[7]*Ministry of Agriculture and Livestock, San José, Costa Rica*

The LivestockPlus consortium was created to enable the development and implementation of Nationally Appropriate Mitigation Actions (NAMAs) for the cattle sector in Costa Rica and Colombia by providing technical support and generating critical information and guidelines necessary to identify appropriate mitigation options and support planning and policies for the scaling up of NAMAs. Costa Rica and Colombia are at intermediate and beginning stages of developing NAMAs for the cattle sector, respectively, and provide sites representative of larger areas of pasture systems in the region. This new initiative seeks to determine what the technical options for low emissions pasture development in Latin America are and how these can be scaled up using NAMAs and other policies. The main objectives of this new project are (1) to characterize the socioeconomic and biophysical contexts in which different cattle farmers operate; (2) quantify country specific greenhouse gas (GHG) emissions from different cattle management options (pasture-based beef, dual-purpose and dairy cattle systems) at different levels of intensification; (3) identify cost-effective methods to monitor and collect information on changes in GHG emissions resulting from different management practices; and (4) build scientific and institutional capacity to develop and test mitigation actions within the target countries. Findings from this study will inform climate change mitigation policy decisions that will enable reduction of GHG emissions while ensuring gender inequalities do not worsen. LivestockPlus will use the two target countries as pilots to provide information while at the same time developing research products applicable to the NAMA discussions regionally and globally. By 2018, policy makers will use the information generated by LivestockPlus to support low emission development (LED) policy and its implementation in the cattle sector. If successfully adopted, scaled-up climate smart practices under a NAMA are estimated to reduce emissions by 10% and improve cattle productivity by 20% thus contributing towards both climate change mitigation and enhanced food security which are linked to climate change adaptation and risk management.

This work is partially funded through the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

81. Venezuelan agriculture N management challenges and proposed alternatives

Pérez Tibisay, Marquina Sorena

Centro de Ciencias Atmosféricas y Biogeoquímica. IVIC. Apartado. 20632, Caracas 1020A, Venezuela

In Venezuela, 26% of the savannas are under agricultural management, but in recent years, large forest areas have been deforested in order to expand the agricultural frontiers, which have several environmental implications (*i.e.* greenhouse gases emission, erosion, soil fertility, water bodies contamination). In general, nitrous oxide (N_2O), which is an important greenhouse gas, and nitric oxide (NO) soil emissions from Venezuelan natural and agricultural soils are large and enhanced in crop soils. Our measured ratios of N_2O flux weighted emission average from crop soils relative to those found in unperturbed savannas are: 5.1 for tillage (T) and 6.8 for no tillage (NT) management. This implies that mitigation strategies are required to reduce N_2O emissions from these crop soils. Monoculture is the main agricultural practice and cereal crops (corn, rice and sorghum) play an important role in the nation food security. Corn crops represent the 65 % of the total national cereal production, and require the application of considerable amounts of N-fertilizer (between 80 to120 kg N/ha per cycle). Nevertheless, studies of nitrogen use efficiency (NUE) for Venezuelan corn crops have shown that only 18 to 48% of N applied is assimilated. Due to the large N_2O emissions from Venezuelan crop soils and N losses to ground waters, we propose the application of biochar as a mitigation strategy to reduce N-losses and to evaluate it's the effect on crop yield. Preliminary leaching experiments from crop soils show significant reduction of nitrate concentration in the first leachate when applied to soils with 8 % of biochar. These results are encouraging to reduce N leaching to ground waters.

82. Nitrous oxide emission factors for sheep and cattle excreta in two subtropical Brazilian grazing systems

Bastos Diego F.[1], Schirmann Janquieli[1], Magiero Emanuelle C.[1], Carvalho Paulo C.F.[2], Bayer Cimelio[1]

[1] *Department of Soil Science and Graduate Program on Soil Science, Faculty of Agronomy, Federal University of Rio Grande do Sul, 91540-000, Porto Alegre, RS, Brazil*

[2] *Grazing Ecology Research Group, Faculty of Agronomy, Federal University of Rio Grande do Sul, 91501-970, Porto Alegre, Brazil*

Nitrous oxide is a major greenhouse gas arising from agricultural activities. Livestock has great impact on global N2O emissions for providing sources of N by grazing animal's excreta. In subtropical environments as in southern Brazil, there is little information over the emission factors (EF) of N_2O from cattle and sheep excreta, and if these EFs are comparable with IPCC indexes (1% and 2% for sheep and cattle excreta, respectively). In two different Subtropical grazing systems (sheep integrated crop-livestock system and cattle in natural grasslands) of Brazil, we conducted field trials to evaluate the emission factor (EF) of N_2O from urine and dung of sheep and cattle. The ICLS trial was set in 3 short field trials (2009, 2010 and 2013, about 40 days each), while a natural grassland trial was carried out in a 1-year trial. In ICLS trials, soil N_2O fluxes varied from -47 to 976 µg N_2O-N m^{-2} h^{-1}, with observed emission peaks until 16 days only after urine application. The average EF for sheep dung (0.05%) was lower than sheep urine (0.21%). The same was found in natural grassland trial, EF from cattle urine was of 0.51%, much higher than of dung (0.06%). In addition, to EF values for subtropical region of Brazil lower than IPCC values, our results evidenced that distinct values of EF should be applied for urine and dung from sheep and cattle.

Acknowledgement: The research leading to these results has been conducted as part of the AnimalChange project which received funding from the European Community's Seventh Framework Programme (FP7/ 2007-2013) under the grant agreement n° 266018.

83. Sustainability of rice cultivation in an important producing area of Cuba under climatic scenarios

Rodriguez Baide Joysee M.[1], van den Berg Maurits[1], Soto Carreño Francisco[2], Maqueira Lopez. Lazaro A.[3], Vázquez Montenegro Ranses J.[4]

[1]*European Commission. Joint Research Centre, Institute for Environment and Sustainability, Monitoring Agricultural ResourceS Unit, Ispra, Italy*

[2]*Instituto Nacional de Ciencias Agrícolas, Mayabeque, Cuba*

[3]*Instituto Nacional de Ciencias Agrícolas, Los Palacios, Cuba*

[4]*Centro de Meteorología Agrícola, Instituto de Meteorología*, *La Habana, Cuba*

Rice plays a major role in the Cuban agricultural sector as it is one of the most important food crop to support the local food systems sustainability. The demand for Cuban grown rice is steadily increasing as the national policy calls for a reduction of imports. Moreover, the decentralization of production leads to expansion of private operations (individuals or cooperatives). Thus, rice production is expanding to a diversity of environments, under various technological levels. On the other hand, natural resources constrain (water, soil) increase of productivity, which could be further exacerbated by regional climate change effects in the area. Indications of climate change in Cuba include significant temperature increase; a shift in seasonal rainfall patterns; an increase in the frequency, length, intensity and geographic extent of extra-seasonal droughts; and an increase in the frequency and intensity of hurricanes. High water demand of rice production makes it highly vulnerable to such effects. Here we present a case study supported by two European Union funded projects; EUROCLIMA and BASAL (Bases Ambientales para la Sostenibilidad Alimentaria Local), aiming at providing tools for national and local decision-making to support adaptation to climatic changes in the country. We used the Biophysical Model Application (BioMA) platform to study different rice production systems prevalent in Cuba and their long-term sustainability against two contrasting climate change scenarios.

L1.4 Europe

84. Innovation for Climate Smart Agriculture in Europe

Touzard Jean-Marc

INRA, UMR 0951 "Innovation", 2 place Viala, F-34060 Montpellier Cedex 01, France

Climate Smart Agriculture (CSA) refers to agricultural systems and derived food chains that are adopting new practices, new technology and new knowledge to address the challenges of both climate change (mitigation and adaptation) and food security (productivity). Following this procedural approach, CSA is thus defined on the basis of innovation processes that are enhancing farming systems and food chains towards the climatic transition. But what are the characteristics of these innovations? Do they concern specific domains, productive systems or actors, as well as specific learning and dissemination processes? Could the climatic axiology generate a "new frontier" for innovation in agriculture?

This communication contributes to responding to these questions by using empirical data from the European KIC climate "CSA Booster" project, and by referring to the theoretical framework of Innovation Studies (evolutionary approach of innovation).

The "CSA booster" project has been funded by the EU for a "pathfinder step" in order to explore the feasibility of services for the promotion of CSA innovations in Europe.

Through this project, 50 "CSA technologies" have been identified, described (on the basis of interviews) and evaluated according to their impacts on productivity, mitigation and contribution to adaptation. Multicriteria analysis (from the technologies database) completed by longitudinal analysis (from the stories told by interviewees) show different kinds of innovation processes. Detected innovations are mainly "technology-pushed", differentiated by their driven actors (public research, big company or start up), technological content, expected impacts and level of development and dissemination.

This empirical evaluation leads to five points of discussion: i) how is private-public partnership implicated in the innovation process, questioning the legitimacy of public intervention into such innovations providing public goods (CSA challenges)? ii) how could "bottom-up and user-pull" innovations better be revealed and connected with the "top-down and technology-pushed" innovations mainly detected in our CSA project? iii) how are specific conditions for CSA innovation linked with new domains of uncertainty, long-term economic return and geographical location? iv) how does the complexity of CSA challenges and assessments call for specific learning processes… involving de facto the researchers of the CSA project? v) how could CSA innovations enter into political debates, becoming either a barrier or an opportunity for the further development of CSA?

Finally these discussions suggest that in Europe, CSA is still at the crossroad between i) the development of a new frontier for (systemic) innovation in agriculture, and ii) a limited epistemic process that tries to promote technology-pushed innovation in agriculture.

85. Nitrogen and water as inputs in farm bio-economic models: creating an operational modeling framework at the EU level

Humblot Pierre, Petsakos Thanasis, Jayet Pierre-Alain

INRA, UMR Economie Publique, Avenue Lucien Bretignières, F-78850 Thiverval Grignon, France

Integrating agronomic information inside economic models is necessary for simulating farming systems, in order to examine how agriculture can adapt to a continuously changing global economic and physical environment. In particular, appropriate integration of water resource and irrigation is key to simulate the impacts of an uncertain future climate. This is of major importance considering the current stress on the water resource in many parts of the world as well as the predicted future interannual variabilities in precipitations and water availability. There is thus a need to extend the modeling tools, in order to tackle the issue of integrating water in farm modeling. In this article, we present a theoretical framework for assigning water-nitrogen yield response functions to different farms in the European Union. This study is based on simulation results of an agronomic model, utilizing all available economic information found in the Farm Accountancy Data Network to calibrate the model and estimate the important parameters of the response function. The method is then applied on the French region "Centre" for different types of agricultural systems and for two irrigated crops, wheat and maize. The obtained functions match the observed yields well, and an estimation of water and nitrogen inputs is provided. We also discuss assumptions for overcoming the problem of missing information regarding water prices. With this approach, we aspire to increase the predicting capacity of bio-economic farm models when used as tools for assessing the economic impacts of changing environmental conditions through a finer consideration of the water used for irrigation.

86. « PigChange »: a project to evaluate the consequences of climate change and mitigation options in pig production

Renaudeau David[1], Gourdine Jean Luc[2], Hassouna Melynda[3], Robin Paul[3], Gilbert Hélène[4], Riquet Juliette[4], Dourmad Jean Yves[1]

[1]*INRA, UMR 1348 PEGASE, F35590 St-Gille, France*

[2]*INRA, UR 143 URZ, F97170 Petit Bourg, France*

[3]*INRA, UMR 1069 SAS, F35000 Rennes, France*

[4]*INRA, UMR 1388 GenPhySE, F31326 Toulouse, France*

Climate change, as suggested by many global climatic models, will impact the economy of livestock production systems worldwide. The general aim of the PigChange project is to combine regional climate projections with models predicting the effect of climate on pig performance to evaluate the degree of vulnerability of French pig industry to climate change and to propose new tools for developing innovative adaptation options for coping with thermal heat stress. The first task of the project focused on modelling approaches to evaluate the impact of climate change on the thermal environment in pig buildings and the consequences of thermal heat stress on daily feed intake and subsequent pig performance. The combination of these models with regional climate projections allowed us to evaluate the degree of vulnerability of French pig producers at different time scales (near and distant future). The second task of the project was dedicated to the evaluation of current coping options (nutrition, housing and genetic) for reducing the effects of thermal heat stress on pig farms profitability. For example, we showed that the maintenance of optimal growth or lactation performances in hot conditions could be obtained in the future by adjusting the dietary composition in attempt to compensate the negative effects of thermal environment on animal's voluntary feed intake. Breeding for heat tolerance, if successful, is a promising approach for mitigating the effect of thermal heat stress on pig performance. Using a modelling approach, we evaluated the possibility to genetically improve pig heat tolerance with conventional breeding selection methods. The last task of the project aimed to generate new insights on predictive direct or indirect biological indicators of heat tolerance. These new tools could lead to propose new coping strategies focused on individual animal management ("precision agriculture" concept) and/or to find new phenotypes for genetic and genomic selection approaches.

The PiGChange project is funded by INRA ("Meta Programme ACCAF").

87. Assessing the economic GHG abatement potential from the EU-15 dairy sector and underlying uncertainties

Koslowski Frank[1], Eory Vera[1], van den Pol-van Dasselaar Agnes[2], Fofana Abdulai[1], de Haan Michel[2], Lesschen Jan Peter[3], Moran Dominic[1]

[1]*Land Economy, Environment & Society Research Group, Scotland's Rural College, Edinburgh EH9 3JG, Scotland, United Kingdom*

[2]*Wageningen UR Livestock Research, Postbus 338, 6700 AH Wageningen, the Netherlands*

[3]*Alterra, Wageningen UR, P.O. Box 47, 6700AA Wageningen, the Netherlands*

The EU-15 dairy sector is a major contributor to total GHG emissions with 123.1 Mt CO_2e in 2009 and projected 112.2 Mt CO_2e in 2020. Addressing the challenges of climate change along with requirements of sustainable intensification and global food security, agricultural GHG emissions need to be reduced, while maintaining or increasing production levels. Given the high complexity and heterogeneity of dairy systems across EU-15, demonstrating an economically feasible abatement potential is important for implementing mitigation policy enforcements. We developed an engineering marginal abatement cost curve (MACC) for the EU-15 dairy sector to estimate the cost of additional GHG abatement for 9 mitigation options in 2020 relative to baseline activities. These mitigation options are optimal fertilisation, reduced tillage, cover crops, reduced fertilisation during winter, animal breeding and feed supplementation by lipids, nitrate, tannins and probiotics. We used the MITERRA-Europe model to estimate GHG emissions and abatement potentials and constructed a model to assess the cost-effectiveness of the mitigation measures. We found that a maximum of 5.7 Mt CO_2e and 1.7 Mt CO_2e at negative cost (*i.e.* cost saving) can be abated by 2020. Most prominent negative cost measures are reduced tillage, dietary probiotics and animal breeding. To understand the uncertainties underlying such a modelling exercise, we conducted Monte Carlo simulations by fitting probability density functions to uncertain parameters that approximate the variance of selected input values that define cost of measures and abatement potential. The uncertainty associated with measure adoption has the largest influence on the MACC estimates. Although the cost-effectiveness ranking of measures is robust, some estimates show significant uncertainty. The analysis highlights the role of reduced tillage, dietary nitrate and animal breeding as the most prominent mitigation options for policy in EU-15.

88. Concerted action for climate smart livestock systems: research & innovation priorities in climate changing Europe

Scholte Martin C.Th.[1,2,3]

[1]*Board of Directors Wageningen UR*

[2]*President Animal Task Force*

[3]*Co-chair GRA Livestock Research Group*

Accounting for an estimated 14,5% of global anthropogenic greenhouse gas emissions, the livestock sector is a substantial contributor to climate change. Research and innovation plays an important role for further improving the sustainability and competitiveness of the animal production sector, with climate change adaptation and mitigation as one of the key challenges. The Animal Task Force (ATF) is a public-private platform of research, farmers & industry organisations from across Europe, working together in fostering knowledge development & innovations to secure the development of sustainable and competitive animal production sector in Europe. The development of climate smart animal production systems that are low-emitting, productive, socially acceptable, resilient and robust is one of the priorities promoted by the ATF. The ATF White Paper on research and innovation priorities and its 2014 Addendum describe integrated approaches needed for developing climate smart animal production systems. Besides support for new knowledge development, mitigating and adopting climate change requires wider adoption of best practices. Together with its partners, ATF is working on concerted action of researchers, industry, governments, societal organisations and farmers to overcome barriers to realising climate smart animal production systems and making Europe a frontrunner in creating new solutions and knowledge sharing around climate smart agriculture. A new publication by the Livestock Research Group of the Global Research Alliance together with the SAI Platform describe twenty-two best practices and emerging options for reducing livestock greenhouse gases in the field of animal breeding and genetics; feed and nutrition; rumen modification; animal health, manure management and grassland management.

89. An observatory of aromatic and medicinal plants as a possible indicator of the climatic changing evolution conditions

Hoxha Valter[1], Ilbert Hélène[2]

[1]UMR TETIS (Mixed Unit of Territories Research, Environment, Remote Sensing and Spatial Information) - House of Remote Sensing - 500 rue Jean-François Breton 34093 Montpellier Cedex 5, France

[2]UMR1110 MOISA (Markets, Organizations, Institutions and Operators Strategies). Campus Montpellier SupAgro / INRA 2 place Pierre Viala 34060 Montpellier Cedex 2, France

Aromatic and medicinal plants are an important source of income for the many of the territories in Albania, particularly those located in the mountain areas. But in the last decade, studies show a decrease in the quantity of harvested plants and habitat degradation. Climate change is certainly involved in the degradation of these resources. Although the influence of climate change is proven by many studies in developed countries (particularly in the agriculture sector), this influence on MAP resources in Albania still remains at a hypothesis state. Indeed, the information produced by phytoecological diagnostics (botanical sampling method) or by conventional methods of investigation are insufficient. They have limitations in time and in space. The objective of this study is to propose a method that supplies information on an observatory MAP in Albania. The establishment of an observatory would test this impact and give to the concerned actors a relevant device to sustainably manage these resources. Data collection is based on a participatory approach (crowdsourcing), which includes the information of local gatherers. GPS tracks are processed and analysed by a model that applies a set of filters to retain only the portions of the track concerned by gathering activities in the strict sense of the term. This model was tested on three types of plant species: sage, rosemary and lime blossom. Despite a limited number of experiments, the model, coupled with the "BD OPAM" database, paves the way for an observatory prefiguring the adaptive management of MAPs. Building a database capable of integrating treatment outcome of the GPS tracks forward the first foundations of an observatory foreshadowing adaptive management of MAP, which also allows seeing the impact of climate factors through the changing habitats.

90. The knowledge hub FACCE MACSUR: Modelling agriculture with climate change for food security

Köchy Martin, Banse Martin

Thünen Institute for Market Analysis, Bundesallee 50, 38116 Braunschweig, Germany

The knowledge hub "FACCE MACSUR" is a network of currently 270 scientists from 18 European and associated countries for improving the European capacity of modelling the effects of climate change and socio-economic changes on agriculture. This concerns crop and grassland production, meat production, farm management related to adaptation and mitigation measures, and development of price relations on national to global markets. The emphasis is on the linking of models and data across scientific disciplines. Collaborative efforts in the network include interactions with decision-makers, farmers, and other stakeholders, agreement on common modelling scenarios for joint evaluation, comparison of model performance, development of new research projects, organization of training courses and workshops, and advancement of modelling methodologies. Researchers in the network are funded by their institutions and in most cases national contracts. The wide range of activities is presented at this conference by examples of scenarios (regional representative agricultural pathways) and regional integrated case studies from Finland, Austria, and Italy. Further information on the project is available from http://macsur.eu with reports on http://ojs.macsur.eu and conference proceedings on http://ocs.macsur.eu.

91. Can functional complementarity of plant strategies enhance drought resilience in associations of Mediterranean grasses?

Barkaoui Karim[1], Bristiel Pauline[2], Birouste Marine[2], Roumet Catherine[2], Volaire Florence[3]

[1]*CIRAD, UMR SYSTEM, 2 place Pierre Viala, 34060, Montpellier Cedex 2, France*

[2]*CEFE UMR 5175, Université de Montpellier – Université Paul Valéry –19 EPHE, 1919 route de Mende, 34293 Montpellier Cedex 5, France*

[3]*INRA, USC 1338, CEFE UMR 5175, Université de Montpellier – Université Paul Valéry –19 EPHE, 1919 route de Mende, 34293 Montpellier Cedex 5, France*

Grasslands are very important agro-ecosystems worldwide but the sustainability of their numerous ecosystem services is threatened under climate change especially in Mediterranean areas. As biodiversity is increasingly recognized to enhance and stabilize processes within plant communities, we aimed to test whether the associations of forage species with contrasting above- and belowground functional strategies improve the use of soil water and the resilience of biomass productivity under increasing summer aridity. Monocultures and bi- or tri-specific mixtures of perennial grasses (native species or cultivars) were compared in a 3-years field experiment under either an average or an extreme summer drought scenario in southern France. From the measured leaf and root traits, both the functional identity (mean traits of associated species) and the functional diversity (trait differences between associated species) were calculated for each mixture. Overyielding and resilience (post-stress vs. pre-stress productivity) were assessed from seasonal aboveground biomass (AGB). Total transpirable soil water (TTSW) and evapotranspiration in summer (ETsum) were derived from monthly soil water content monitoring. Overall, response patterns were similar between native species and cultivars. Across all treatments and drought scenarii, AGB productivity and resilience were highly correlated with TTSW, ETsum and rooting depth. The functional identity of mixtures better explained overyielding and resilience responses than the functional diversity. However, the effects associated with functional complementarity between root traits may have greater impacts on mixture drought resilience on a longer term. These results showing the role of root traits and water-use on the resilience of perennial mixtures provide sound agro-ecological rules to design suitable associations of species for drought-prone areas.

92. Incremental adaptation in crop management for integrated assessments of climate change impacts in Europe

Webber Heidi[1], Britz Wolfgang[2], Zhou G.[1], de Vries Wim[3], Wolf Joost[4], Ewert Frank[1]

[1]*INRES, University of Bonn, Bonn, Germany*

[2]*ILRI, University of Bonn, Bonn, Germany*

[3]*Alterra, Wageningen University, Wageningen, the Netherlands*

[4]*Plant Production Systems, Wageningen University, Wageningen, the Netherlands*

Decision making around the future of European arable agriculture requires understanding how climate change and the underlying economic drivers may affect European cropping systems, including future crop management. In response to long term, slowly changing variables, it is expected that farmers will make incremental adaptations in crop management. This study aims to quantify the importance of (1) adjusted sowing dates and (2) cultivar thermal time requirements in integrated assessment climate impact studies. Relative yield changes with and without optimized sowing and thermal times were simulated with the SIMPLACE crop modelling framework for seven crops across Europe for three climate change scenarios between 2004 and 2050. As crop management may not be optimized in reality due to factors not currently accounted for in crop models, we also quantify yield gains of optimized management in the baseline period. These currently unrealized relative yield gains were subtracted from future yield gains resulting from optimized management under climate change. Averaged across crops and Europe, climate change in the A1B1 scenario yields were almost unchanged (+1%) with no adaptations, whereas optimized management lead to 20% yield increases. However, when adjusted for the non-realized potential to optimize current yields, the yield increase drops to 6%. The relative changes are in all cases more positive for winter sown crops. These yield changes were supplied to CAPRI, a comparative static partial equilibrium model for the European agricultural sector, to simulate production, prices, farm income and trade. The resulting differences found when adaptation was considered in CAPRI were not dramatic, but in a similar magnitude as those found between the different SRES and climate scenarios. This study thus illustrates that considering relatively simple farm management adaptations to climate change can considerably impact findings in integrated assessment studies, while cautioning to also reflect on non-optimized behavior ex-post and ex-ante.

93. Sensitivity of maize to climate change in Denmark: an analysis using impact response surface approach

Ozturk Isik, Sillebak K. Ib, Olesen E. Jørgen

Department of Agroecology, Aarhus University, Blichers Alle 20 DK-8830, Tjele, Denmark

In Denmark, the traditional fodder crops are being substituted by maize due to both climatic and non-climatic conditions. However, there is insufficient knowledge on nitrogen (N) use of maize and related agro-ecological consequences considering the climate change. In this study, we examined the sensitivity of maize using the impact response surface method across ninety-nine sensitivity tests covering an uncertainty space in temperature, precipitation, and CO_2. The changes of climate variables extend within the climate extremes projected by CMIP5. The tests were generated using a Latin Hypercube sampling method and the changes were applied to a baseline (1999 - 2011). A soil-crop model (FASSET) was used to simulate the maize growth in response the climate change. FASSET was calibrated and validated using data that were collected from field experiments conducted in 2009 – 2011 in Denmark at two sites with different soil characteristics under rotations with and without catch crops, using different fertilization rates and types at 1N, ½N, and 1½N. The experiments included 10-year cropping history of either maize for silage, or grass-clover.

We have analyzed the sensitivity of maize, and N dynamics using mixed-effect analysis. We aimed to better understand the relative contributions of individual climate variables and their interactive effects on maize growth and N balance.

We presented a visual indication of maize yield, and N dynamics across temperature, rainfall and CO_2 change. The initial results indicated that temperature during growing season was the most important variable affecting maize yield. CO_2 concentration in the atmosphere and precipitation has also affected maize via decreased crop transpiration. The availability of mineral N decreased with increased temperature. Increased N fertilization did not increase yield, but increased N leaching. Catch crops were found to be beneficial in reducing N leaching, and their introduction with earlier maize sowing dates was assessed.

94. Is it possible to reduce greenhouse gas emissions without reducing production? An assessment of 26 technical options

Pellerin Sylvain[1], Bamière Laure[2], Angers Denis[3], Béline Fabrice[4], Benoît Marc[5], Butault Jean-Pierre[6], Chenu Claire[7], Colnenne-David Caroline[8], De Cara Stéphane[2], Delame Nathalie[2], Doreau Michel[5], Dupraz Pierre[9], Faverdin Philippe[10], Garcia-Launay Florence[10], Hassouna Melynda[11], Hénault Catherine[12], Jeuffroy Marie-Hélène[8], Klumpp Katja[13], Metay Aurélie[14], Moran Dominic[15], Recous Sylvie[16], Samson Elisabeth[11], Savini Isabelle[17], Pardon Lénaic[17]

[1]*INRA, UMR ISPA, 33882 Villenave d'Ornon, France*

[2]*INRA, UMR Eco-Pub, 78850 Thiverval-Grignon, France*

[3]*Agriculture et Agroalimentaire Canada, Québec (Québec), G1V2J3, Canada*

[4]*IRSTEA, UR GERE, 35044 Rennes, France*

[5]*INRA, UMR Herbivores, 63122 Saint-Genes-Champanelle, France*

[6]*INRA, UMR LEF, 54042 Nancy, France*

[7]*AGROPARISTECH, UMR IEES, 75005 Paris, France*

[8]*INRA, UMR Agronomie, 78850 Thiverval-Grignon, France*

[9]*INRA, UMR SMART, 35011 Rennes, France*

[10]*INRA, UMR PEGASE, 35590 Saint Gilles, France*

[11]*INRA, UMR SAS, 35042 Rennes, France*

[12]*INRA, UR USS, 45075 Orléans, France*

[13]*INRA, UR Ecosytème Prairial, 63039 Clermont-Ferrand, France*

[14]*SUPAGRO, UMR SYSTEM, 34060 Montpellier, France*

[15]*SRUC, Land Economy and Environment Research, EH9 3JG, Edinburgh, United Kingdom*

[16]*INRA, UMR FARE, 51686 Reims, France*

[17]*INRA, DEPE, 75338 Paris, France*

In Europe, agriculture is responsible for 10.2% of greenhouse gas (GHG) emissions. The objective of this study was to assess technical measures to reduce GHG emissions at the farm level without reducing production outputs. France was chosen as a case study with a typical intensive and diversified agriculture. Ten measures, split into 26 sub-measures, were selected from an initial list of 100 "candidate" measures. The selection process was based on five criteria: the expected effect on production, the GHG abatement potential, the current availability of the technology required to implement the measure, the applicability of the measure, including its social acceptability, and the potential synergies or antagonisms with other agri-environmental objectives, including adaptation to climate change. The ten selected measures were linked to nitrogen management, management practices which increase carbon storage in soils and biomass, livestock diets and energy production and consumption on farms. Their abatement potential and cost were accurately calculated and compared, using a marginal abatement cost curve approach. Results show that one third of the cumulated abatement potential corresponds to sub-measures with a negative cost. These sub-measures are based on an improved efficiency of inputs like N fertilizers, animal feed and energy, with no negative effect on production. Moreover, no antagonism with the objective of adaptation exists for these sub-measures. Other sub-measures are characterised by a higher cost, because of specific investments, the purchase of specific inputs or dedicated labour time, sometimes partially compensated by additional marketable products (biogas, wood...). Among the 26 sub-measures, only four exhibit a slight antagonism with the objective of adaptation to climate change. When calculated under current inventory rules, the overall annual abatement represents 10% of annual emissions from agriculture. This percentage is higher when calculated using higher tiers. It is concluded that cost-effective technical levers exist for agriculture to support greenhouse gas mitigation without hampering production and adaptation goals.

95. Agroforestry for a climate-smart agriculture – a case study in France

Cardinael Rémi[1,4], Chevallier Tiphaine[1], Germon Amandine[3], Jourdan Christophe[2], Dupraz Christian[3], Barthès Bernard[1], Bernoux Martial[1], Chenu Claire[4]

[1]*IRD, Umr Eco&Sols, 34060 Montpellier, France*

[2]*CIRAD, Umr Eco&Sols, 34060 Montpellier, France*

[3]*INRA, Umr System, 34060 Montpellier, France*

[4]*AgroParisTech, IEES, 78850 Thiverval-Grignon, France*

Agroforestry is a land use type where crops and trees are grown together in the same place and at the same time. Agroforestry systems have the advantage of providing multiple products (*e.g.* wood, fruits) or services (*e.g.* biodiversity enhancement, erosion control) whilst maintaining agricultural production. If they are known to store carbon into the biomass of the trees, they could also increase soil organic carbon (SOC) stocks. However their impact has rarely been studied under temperate conditions and has mostly concerned superficial soil layers. Our objectives were (i) to quantify and spatialize SOC stocks in an agroforestry system and in an adjacent agricultural plot, (ii) to assess what SOC fractions are responsible for possible additional carbon storage, and (iii) to quantify all organic inputs entering the soil. The trial was established in 1995 in southern France. Hybrid walnut trees are intercropped with durum wheat. SOC stocks were measured on 200 soil cores down to 2 m soil depth, and particle-size fractionation was performed on 64 soil samples. Carbon stocks of trees and of the herbaceous vegetation in the tree rows were also quantified. A trench was dug to 4 m soil depth to quantify tree fine root distribution and biomass. Minirhizotrons were installed at different depths to study tree fine root turnover. Annual additional SOC storage rates were estimated at 259 ± 59 kg C ha^{-1} yr^{-1} (0-30 cm) and at 350 ± 88 kg C ha^{-1} yr^{-1} (0-100 cm), and were mainly due to particulate organic matter fractions (> 50 µm). Only 10 to 15% was associated to clay particles. When the biomass of the trees was taken into account, total organic carbon storage rate reached 1.2 Mg C ha^{-1} yr^{-1}. High tree root densities were observed at depth, but root turnover decreased with depth. Agroforestry systems provide higher amounts of carbon at depth than other agricultural practices, like no-till farming, and could therefore provide a more stable C storage in the long-term.

This study was funded by ADEME within the Agripsol project as part of the Réacctif program.

96. Impacts of climate and socio-economic change at farm and landscape level in the Netherlands: climate smart agriculture?

Reidsma Pytrik[1], Bakker Martha M.[2], Kanellopoulos Argyris[1,3], Alam Shah J. [4], Paas Wim[1,5], Kros Johannes[6], de Vries Wim[6,7]

[1]*Plant Production Systems Group, Wageningen University, P.O. Box 430, 6700 AK Wageningen, the Netherlands*

[2]*Land Use Planning Group, Wageningen University. P.O. box 47, 6700 AA Wageningen, the Netherlands*

[3]*Operational Research and Logistics Group, Wageningen University, Hollandseweg 1, 6706 KN Wageningen, the Netherlands*

[4]*School of GeoSciences, University of Edinburgh, Drummond Street, Edinburgh EH8 9XP, United Kingdom*

[5]*Farming Systems Ecology Group, Wageningen University, P.O. Box 430, 6700 AK Wageningen, the Netherlands*

[6]*Alterra Wageningen UR, P.O. box 47, 6700 AA Wageningen, the Netherlands*

[7]*Environmental Systems Analysis Group, Wageningen University, P.O. Box 47, 6700 AA Wageningen, the Netherlands*

Research on climate-smart agriculture requires models that include adaptation and transformation at the farm and landscape scale; multifunctional solutions for agronomic, ecological and socio-economic challenges; and scenarios validated by evidence and metrics. Therefore, this study used a bio-economic farm model, a land-use change model, and a regional emission model to simulate economic, social, and environmental impacts of changes in climate, technology, policy, and prices at both farm and landscape level. The case study was performed in the watershed 'the Baakse Beek' (the Netherlands), dominated by dairy farming on mainly sandy soils. Results show that in the Baakse Beek area, climate change will have mainly negative economic impacts (dairy farm income, arable farm income, efficiency, milk production) in the more extreme 'global economy' climate change scenario (GE), while impacts are slightly positive in the moderate climate change scenario 'regional communities' (RC). Conversely, changes in technology, prices, and policy are projected to have a positive economic impact in the GE scenario, largely offsetting the negative climate impacts. Nevertheless, their social (farm size, number of farms, landscape diversity, nature area) and environmental impacts (global warming, terrestrial & aquatic eutrophication, acidification nature areas) are largely negative. In the RC scenario the average dairy farm income in particular is negatively affected. Social impacts are similarly negative, while environmental impacts are less severe. We conclude that autonomous developments and adaptation do not comply with climate smart agriculture. Integrated assessments at farm and landscape level such as these can be used to guide decision-makers in spatial planning policies and climate change adaptation and mitigation. As there will always be trade-offs between economic, social and environmental impacts, stakeholders need to interact and decide upon most important directions for policies.

97. Sustainability of agriculture: can climate change adaptations attract youth into agriculture?

Betigül Onay Özman

YADA Foundation (Yaşama Dair Vakıf), Turkey

Climate change is not only an environmental problem but a sustainable development issue with socioeconomic factors, requiring a multidimensional approach. Farming in Turkey faces two main challenges: demographic and environmental. Studies show the average age of a farmer is between 45-55 years old and increasing. Youths do not find farming attractive; preferring to earn less living in urban areas, in comparison to earning twice more by farming in rural areas. Families do not encourage youngsters to continue farming. Hence, farming is facing a sustainability problem. The problem is not unique to Turkey. Average age of a farmer in the USA is 58, in Japan 66, and more than one third of European farmers are older than 65. Increasingly, we see international organizations such as FAO, the UN and European Union focusing on this issue and working groups such as 'European Council of Young Farmers', 'Young Professionals in Agricultural Research for Development' and 'National Young Farmers Coalition' forming.

The environmental challenge facing agriculture is climate change. Precipitation is decreasing and temperature is increasing while extreme weather events are becoming more frequent. Turkey's climate, topography, soil conditions, and its socio-economic characteristics, indicate that two-thirds of Turkey is considered arid and suffers from water shortages, making Turkey highly sensitive to desertification and drought.

The solutions are entwined in both problems. Turkey, along with other countries, could target both challenges simultaneously by presenting tools to professionalize farmers and their farmer organizations which will lead them to apply climate smart agricultural practices. Using technology and relying on networks to apply climate smart agriculture will enable farmers to become more professional, hence increase their reputation and attract youngsters into farming. These practices will make the farming community more resilient to climate change.

L1.5 North America

98. A research program to address agricultural stakeholders' concerns regarding the evolution of crop pests associated with climate change

Blondlot Anne[1], Gagnon Annie-Ève[2], Bourgeois Gaétan[3], Brodeur Jacques[4], Mimee Benjamin[3] and colleagues

[1] *Ouranos, Montreal, Quebec, Canada*

[2] *Centre de recherche sur les grains (CÉROM), Saint-Mathieu-de-Beloeil, Quebec, Canada*

[3] *Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, Quebec, Canada*

[4] *Institut de recherche en biologie végétale, Université de Montréal, Montreal, Quebec, Canada*

Quebec agricultural stakeholders have expressed strong concerns about the risk of increased pressure from pests on crops in the context of climate change given the sensitivity of these organisms to climate variations. Ouranos, a Quebec based consortium of regional climatology and adaptation expertise, supported three research projects that shared expertise and climate change scenarios. Those projects combined several methodological approaches such as modeling, climate analogues, surveys and literature reviews. One of the three projects highlighted the impact of climate change on crop pests already present in Quebec via case studies. Another project considered the future risk of establishment of invasive alien species in soybean crops. Finally, a third project analyzed the impact of global warming on the synchronization between the life cycle of pests and their natural enemies. As a boundary organization, Ouranos makes the connection between science and the needs of end-users. These projects confirmed that several actions proposed in the Quebec Pest Management Strategy 2011-2021 for agriculture also contribute to adapting to climate change. In addition, the results of the projects helped guide the Quebec Climate Change Action plan 2013-2020 towards activities to strengthen the monitoring network and to develop new diagnostic methods for crop pests. The projects also helped to build capacity and expertise in plant protection and climate change in Quebec. The results of the projects were transferred to end-users in a number of agriculture conferences held in the province and many outreach products were disseminated on a website dedicated to agricultural expertise that is widely used in Quebec.

99. Bioenergy crop impacts on soil carbon sequestration, soil biophysical properties and N_2O emissions in Manhattan, Kansas

McGowan Andrew[1], Yishak Elias[2], Rice Charles[1]

[1]*Department of Agronomy: Kansas State University, 66506, Manhattan, United States*

[2]*Department of Mechanical Engineering: University of Maryland, 20742, College Park, United States*

The 2007 Energy Independence Security Act mandates the production of 60 billion liters per year of cellulosic biofuel by 2022, which will be required to have life cycle assessment greenhouse gas (GHG) emissions at least 60% below those of gasoline/diesel. Careful management and selection of bioenergy crops could reduce GHG emissions from ethanol production by encouraging soil organic carbon (SOC) sequestration and reducing nitrous oxide (N_2O) emissions in soils. The objectives of this study were to evaluate the impact of perennial and annual cellulosic ethanol crops on soil physical and biological properties, changes in SOC stocks and N_2O emissions. Plots containing switchgrass, miscanthus, big bluestem, corn, photoperiod sensitive sorghum, sweet sorghum and grain sorghum were established in Manhattan, Kansas, USA in 2007. In 2013, root stocks and water-stable aggregates (WSA) were measured. Phospholipid and neutral lipid fatty acids (PLFA and NLFA) were also measured to assess microbial community structure between crops. SOC stocks were measured to a 120 cm depth after the 2009 and 2013 growing seasons. Annual N_2O emissions were measured from soils in a subset of the crops from 2011 through 2013 using static chambers. No significant differences were found in N_2O emissions between crops due to high variability in measurements, though miscanthus tended to have the lowest emissions. Perennial grasses had significantly higher total root stocks than the annual crops. The concentration of the NLFA biomarker for arbuscular mycorrhiza and the PLFA fungi:bacteria ratio in miscanthus were higher than those of all other crops at 0 – 5 cm. Miscanthus and switchgrass had more macroaggregates and less microaggregates than the annual crops at 0 – 5 cm. Over 4 years, miscanthus and big bluestem sequestered SOC at 0 – 15 cm while annual systems lost or maintained SOC stocks. These results demonstrate the high climate mitigative capacity of perennial crops used for bioenergy.

100. Understanding farm level N_2O emissions in California systems

Decock Charlotte[1], Verhoeven Elizabeth[1], Pereira Engil[1], Garland Gina[1], Kennedy Taryn[2], Suddick Emma[3], Burger Martin[4], Horwath Willam[4], Six Johan[1]

[1]*ETH Zurich, Department of Environmental Systems Science, 8092 Zurich, Switzerland*

[2]*University of California Davis, Department of Plant Sciences, 95616 Davis, California, USA*

[3]*Woods Hole Research Center, 02540-1644 Falmouth, Massachusetts, USA*

[4]*University of California Davis, Department of Land, Air and Water Resources, 95616 Davis, California, USA*

Mitigating nitrous oxide (N_2O) emissions is an important topic in the context of Climate Smart Agriculture. N_2O is a potent greenhouse gas and stratospheric ozone depleting substance that is predominantly emitted from soil under agricultural management. In an effort to characterize baseline N_2O emissions and the potential of mitigation options for California cropping systems, we compiled a set of twelve studies encompassing 22 annual N_2O budgets across seven cropping systems, conducted during the period 2009-2013. Mean emissions across all observations were 1.30 ± 0.89 kg ha^{-1} N_2O-N yr^{-1} and the mean emission factor (the percent of N applied emitted as N_2O-N) was 1.5 ± 2.5%. Significant emissions occurred in both the growing season and the fallow/winter season, and showed significant differences between functional locations within the field (*e.g.* on the berm vs. in the furrow). While fertilization induced significant emissions in all studies, emission factors varied greatly between crops. Aside from fertilization, irrigation and crop or cover crop residue management were the two management practices that appeared to affect annual emissions the most. Both buried drip and microjet irrigation showed mitigation promise. While the compiled studies suggest that judicious and synchronized application of water and N, timed with crop demand, is likely to reduce emissions, we do not have sufficient information on baseline emissions nor an adequate spread of data on varied management practices across systems to delineate robust emission reduction quantification approaches. Building on the currently available data, a combination of modeling and measurement approaches could help to strategically collect the information required to develop concrete action plans for N_2O mitigation from California agriculture.

101. A transdisciplinary approach for climate smart management of maize

Wright Morton Lois, Arritt Raymond, the CSCAP Team

Iowa State University, Ames, Iowa 50011, USA

The Sustainable Corn Project is a transdisciplinary team of biological, social, and physical scientists working to understand and reduce the risks to agricultural production imposed by our changing climate. A 140 member team is addressing interactions of climate and cropping systems in the U.S. corn belt through research, education, and extension of science to public stakeholders. The team integrates agricultural, engineering, social, and climate sciences with stakeholder knowledge to discover relationships among climate, carbon, water, nitrogen and human behaviors in maize-based cropping systems. Our goal is to assess historical and future interactions of this cropping system with climate in order to increase the resilience of the cropping system while decreasing its environmental impacts. In this presentation we discuss advantages and challenges of transdisciplinarity as an approach for integrating coupled human-natural systems research with agricultural stakeholder applications. This approach requires careful attention to organizational structures and processes in order to reach its goals efficiently and effectively. These include emphasis on communication and coordination, which are accomplished through formal and informal workgroups as well as regular communication amongst leadership and the entire team. The team uses research outputs of various workgroups as inputs to other workgroups to integrate knowledge about human-natural systems, synthesize and build new models, and develop management applications and recommendations for producers and other stakeholders. Examples of findings from our transdisciplinary research will be shown, such as a case study of the nexus of sociological, agricultural, climatic, and hydrologic causes and effects associated with farmer adoption of drainage water management.

Acknowledgment: This research is part of a regional collaborative project supported by the USDA-NIFA, Award No. 2011-68002-30190, "Cropping Systems Coordinated Agricultural Project (CAP): Climate Change, Mitigation and Adaptation in Corn-based Cropping Systems." Web site: sustainablecorn.org.