CLIMATE-SMART
Agriculture
2015

Global Science Conference

March 16-18, 2015
Le Corum, Montpellier France

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Assistant Director-General, Agriculture and Consumer Protection Department, FAO

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Institute of Biological Sciences & Scottish Food Security Alliance-Crops, University of Aberdeen, Aberdeen, AB24 3UU, United Kingdom

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High Level Panel of Experts on Food Security and Nutrition (HLPE), Steering Committee Member
High Commissioner for Food Security to the President of the Republic of Niger

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Adaptation, Resilience and Climate Smart Agriculture – from concepts to action

Meinke Holger[1,2], Baethgen Walter[3], Meza Francisco[4], Campbell Bruce[5]

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9:30 Plenary Keynote P3.2: Sustainable intensification and mitigation

Sustainable intensification and mitigation

Bustamante Mercedes M.C.
University of Brasilia, Brazil

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Agroecology *is* climate smart

Pablo Tittonell[1,2]
[1]*Farming Systems Ecology, Wageningen University, the Netherlands*
[2]*Centre de coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), France*

10:30 Plenary Keynote P3.4: Food security and food systems

Climate-smart food systems

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Department of Plant and Environmental Sciences, University of Copenhagen, Thorvaldsensvej 40, 1871 Frederiksberg C., Denmark

SPECIAL PLENARY KEYNOTE ON LAND DEGRADATION AND DESERTIFICATION

Tuesday, March 17

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Payne William A.
University of Nevada, USA

Plenary 2:

Global Dimensions

Monday, March 16 2015

11:00–13:00

AUDITORIUM PASTEUR

11:00 Plenary Keynote P2.1: Climate change, risks, extremes and uncertainties

Climate Change: from global alert to local studies

Le Treut Hervé

Laboratoire de Météorologie Dynamique/ Institut Pierre-Simon Laplace, Université Pierre et Marie Curie, Paris, France

During the last decades the perspectives concerning climate change have evolved continuously, creating a new situation, where the quick development of adaptation policies becomes necessary. The implication for climate change science is very large, because adaptation requires information at a local or regional scale, which goes beyond what is achievable by current (and may be by future) model architectures.

All nations prepare to meet in Paris in December 2015 for the COP21, to set up an ambitious plan to diminish greenhouse gas emissions, by 40 to 70% in 2050. This follows the results of the AR5 IPCC report, defining the emission path toward a stabilization of global surface temperatures under the target of 2°C warming, target agreed by all nations. The measures taken in Paris are expected to become effective in 2020. But in the meantime, the situation is still that of increasing emissions. Considering only carbon dioxide emissions from the use of fossil fuels, they have reached a level of approximately 10 billion tons of carbon per year, compared to 6 or 7 at the time of the 1992 Earth Summit in Rio. This tendency is structural, and may be considered as a delayed effect of demographic increase, with new emerging countries becoming important contributors. Curving down emissions is still a difficult objective ahead of us.

At the same time the AR5 IPCC report also shows many indications that climate change associated with greenhouse gas emissions is now superimposing its effects upon natural climate variability, possibly also modifying this variability. But this diagnosis does not indicate that the future evolution of climate at local and regional scales may become predictable in the near future. Climate change over any region depends on how the major modes of natural variability will be distorted. Over Europe, for example, a change of the North Atlantic Oscillation will have almost opposite effects depending on whether the negative or the positive phase of the oscillation is favored. The latter situation is more commonly simulated by models, but the situation may change from one year to the other. The results of the Coupled Model Intercomparison Programme (CMIP5) summarized in the AR5 show a striking difference between the current capacity to predict various parameters. Whereas all models agree on a systematic surface warming, and whereas the risk associated with sea-level rise is also clearly agreed upon, divergence between models is still the rule when it comes to local precipitation evolution. Although we know, for example, that the warming should favor stronger precipitations, because warmer air contains more water vapor, the localization of such effects is made highly uncertain by the difficulty of predicting changes in the large scale atmospheric dynamics. The same situation occurs for droughts or extreme events.

This situation has generated several types of actions in the scientific community, two of which will be presented at the conference through specific examples:

1. The setup of "Climate Services" where the information from the different models of the international community will be distributed to potential users. This information provides an access to a probabilistic approach of local and regional climate risks. But the possible misuse of this information also creates a risk of defining equivocated policies leading to maladaptation, and it cannot be distributed without also sharing some associated scientific expertise. We will briefly review the current efforts to set up Climate Services at IPSL. These efforts are coordinated with those at Meteo-France, and accessible in a preliminary manner through the DRIAS project (http://www.drias-climat.fr) and the Web "IPSL Climate Services and Expertise" (http://cse.ipsl.fr)

2. Actions to provide a direct link between the scientific community and policy planners. We will present a study which has been made over the Aquitaine region (South-West of France) and published in French only (as a book: Changements Climatiques en Aquitaine, direction H. Le Treut, 2013, Presses Universitaires de Bordeaux, 330 pages). Its objective has been to gather the information available in public laboratories which is pertinent to determine the vulnerability of different sectors of activity to climate risks. We will discuss what may be the relative role of scientific expertise and political debates to define future policies concerning adaptation to climate changes

11:30 Plenary Keynote P2.2: Climate-Smart agriculture: conceptual framework and brief history

Climate-Smart agriculture: conceptual framework and brief history

Wang Ren

Assistant Director-General, Agriculture and Consumer Protection Department, FAO

Climate smart agriculture is a recent concept and approach launched by FAO in 2010 in response to the growing need for a clear and coherent strategy for managing agriculture and food systems under climate change. CSA belongs to the family of programmatic concepts, conceived at the interface between knowledge and policy making, in an international setting, as a way to orient and ground policies and action. CSA strives to attain three objectives: 1) sustainably increasing agricultural productivity to support equitable increases in incomes, food security and development; 2) adapting and building resilience to climate change from the farm to national levels; and 3) developing opportunities to reduce GHG emissions from agriculture compared with past trends. To do so it needs to combine practices, policies and institutions as well as finances. This talk gives a brief history of the development of the concept and applied approach within FAO and other organizations. It then goes on to outline a conceptual framework for the approach and its relationship to other major conceptual frameworks in the sustainable agriculture and climate change context. The talk concludes with some examples of the application of the CSA approach – and some of the major research gaps that are still being faced.

The CSA concept was first developed in the FAO background document "Climate-Smart" Agriculture, Policies, Practices and Financing for Food Security, Adaptation and Mitigation, prepared for the Hague Conference on Agriculture, Food Security and Climate Change, released in October 2010. This report emphasized the central role of agricultural transformation for food security, and thus the need to frame adaptation and mitigation around this priority. The CSA concept emerged from a confluence of strategies and research on climate change, food security and agriculture issues. Adaptation and mitigation were often treated separately, but it is clear that in the context of agriculture and food security it could be counter-productive to maintain this divide, and potential synergies across the objectives would be lost and thus in 2009 FAO already called for an integrated "climate smart agricultural development". It also builds on the work of the World Bank World Development Report on Climate Smart Development in 2010 and the CGIAR challenge program on climate change, agriculture and food security. In 2011, the first Global Climate Smart Agriculture Science Conference held at Wageningen University in 2011 contributed to the sharpening of the CSA concept, as did the subsequent CSA Science Conference held at UC Davis in 2013. Numerous organizations and individuals contributed to the CSA Sourcebook which provided a wide range of CSA applications and examples across crop, livestock, fishery and forestry sectors – as well as on the policy, institutional and financing aspects.

The conceptual framework of CSA is rooted in the concept of food security and its four dimensions of availability, access, stability and utilization. How agriculture and food systems are managed drives the outcomes across all four dimensions: agricultural production and productivity determine the availability of food supplies; agricultural markets and food chains affect food prices and access to food, as does the distribution of the benefits and incomes to agricultural producers, resilience in production systems and value chains are essential determinants of stability and the nutritive quality, safety and waste associated with agricultural processing and food chains underlies utilization. Even in the absence of climate change, the world will face major challenges to achieve success across all four dimensions of food security. Climate change magnifies and augments these challenges.

The conceptual framework of CSA has three main points of departure: 1) Food production will have to increase, due to population growth and changing dietary patterns 2) Climate change is already affecting and will affect food security and nutrition, especially for the poorest and most vulnerable, 3) With production increase, business as usual emissions will increase. Agriculture, here taken in the broad FAO sense to include crops, livestock, fisheries and forestry, has to address simultaneously three intertwined challenges: ensure food security, adapt to climate change and contribute to mitigate climate change. Addressing these challenges requires changes not only in the production systems and practices employed on farms, fisheries and in forests, but in the institutions and policies governing them. To achieve the level of transformation required, additional finance more suitably tailored to the specificities of agriculture and food systems is needed.

Resilience and resource use efficiency are intrinsic to the CSA concept. Resilience can be described as the capacity of systems, communities, households or individuals to prevent, mitigate or cope with risk and recover from shocks. The effect of climate change on increasing exposure to shocks augments the importance of building resilience in the production and food systems. Resource use efficiency is an essential step to achieving higher productivity at lower costs in terms of resource use, thus increasing production and incomes which is an essential part of adaptation. Resource use efficiency is also fundamental to mitigation as GHG emissions from agriculture are linked to its use of resources.

Since its launch, the CSA concept has encountered growing success but, as is often the case with such type of broad concept designed in an international setting and aiming to be used in various diverse situations, is sometimes misinterpreted. One common misconception is that CSA is a new technology with win-win-win properties across food security, adaptation and mitigation outcomes. Actually CSA is an approach for identifying potential synergies and tradeoffs across a range of feasible options for technology and practice change in agriculture and for managing these synergies and tradeoffs taking into account the four dimensions of food security and according to national and local priorities. The approach is used to identify the most suitable strategy for local conditions, but doesn’t imply that every practice and measure, every farmer, in every field will contribute to all three objectives. The CSA approach does require consideration of all three of the objectives but also recognizes the priorities vary across circumstances, and food security with necessary adaptation are clearly priorities, particularly in low income countries with a high share of the population dependent on agriculture for their livelihoods. Another major misconception is that CSA mandates a link between carbon markets and agricultural producers and prioritizes mitigation over food security. Linking climate finance to climate smart agricultural investments is also a key tenet of CSA, in order to provide the level of investment finance required to achieve a major transition. In the developing country context, CSA focusses primarily on public sector sources such as Green Climate Fund and Global Environment Fund and working through country driven policy processes such as the development of Nationally Appropriate Mitigation Actions (NAMAs). CSA has been criticized for ignoring other major environmental issues such as biodiversity conservation and water management. Through its emphasis on resilience these factors do actually play an important role in CSA, and actually they assume even greater importance under the new realities of climate change.

12:00 Plenary Keynote P2.3: Impacts and adaptation of agriculture to climate change and climatic variability

From climate adaptation assessment to action and back again: a food system perspective

Howden Mark, Crimp Steven, Lim-Camacho Lilly, Dowd Anne-Maree

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The potential challenges from climate variability and change to agriculture are substantial and interact strongly with other potential drivers of change. Here we summarise the key potential impacts on food production and its variability, recognising that other elements of food security, such as access and utilization, will also be affected by climatic changes, as drawn from inter alia CCAFS research and the recent IPCC Working Group 2 report. This report identified a substantial gap in the literature on how climate change may disrupt the food system beyond production, along the value chain, affecting food availability and stability. There was also a lack of coverage of livestock systems especially in terms of adaptation options.

The IPCC report specifically identified a range of potential adaptation measures and ways of measuring adaptive capacity but acknowledged the lack of progress in developing implementation pathways for these options: in essence, noting the need to move from assessment to adaptation action. The central premise behind adaptation is that this is essentially a common-sense action/reaction, with failure to react resulting in either underperformance or increased risk. For this reason there is both an inherent private interest in being well-adapted to change as well as a broader public interest through enhancing food availability and stability.

This need to juxtapose both private and public interest is recognised as a major challenge in moving towards tangible adaption action particularly when including the paired objectives of emission-reduction and economic sustainability. Our approach to this adaptation dilemma is to examine and define the problem space from a ‘problem of transition’ perspective (what degree, of what change, at what time, to what, by whom), including looking at issues of path dependency, teleconnections, institutional framing and social networks. We suggest that the existing agronomic, production focus will not allow the full contribution that science can make to resolve the food availability and stability challenge and that there is an increasing need for greater diversity and integration of multiple approaches to research in this domain. We show that by using this approach the likelihood of assessment being translated into action is greatly increased.

12:30 Plenary Keynote P2.4: Supply and demand based greenhouse gas mitigation

Supply and demand based greenhouse gas mitigation

Smith Pete

Institute of Biological Sciences & Scottish Food Security Alliance-Crops, University of Aberdeen, Aberdeen, AB24 3UU, United Kingdom

Feeding 9–10 billion people by 2050 and preventing dangerous climate change are two of the greatest challenges facing humanity. Both challenges must be met while reducing the impact of land management on ecosystem services that deliver vital goods and services, and support human health and well-being. Few studies to date have considered the interactions between these challenges.

The supply- and demand-side climate mitigation potential available in the Agriculture, Forestry and Other Land Use (AFLOU) sector, as synthesised in the IPCC WGIII AR5 are briefly reviewed, with a special focus on animal agriculture. Some of the synergies and trade-offs afforded by mitigation practices are outlined, before an assessment of the mitigation potential possible in the AFOLU sector under possible future scenarios is presented, in which demand-side measures co-deliver to aid food security. I conclude that while supply-side mitigation measures, such as changes in land management, might either enhance or negatively impact food security, demand-side mitigation measures, such as reduced waste or demand for livestock products, should benefit both food security and greenhouse gas (GHG) mitigation.

Demand-side measures offer a greater potential (1.5–15.6 Gt CO_2-eq. yr-1) in meeting both challenges than do supply-side measures (1.5–4.3 Gt CO_2-eq. yr-1 at carbon prices between 20 and 100 US$ tCO_2-eq. yr-1), but given the enormity of challenges, all options need to be considered (Smith *et al.*, 2013).

Supply-side measures should be implemented immediately, focusing on those that allow the production of more agricultural product per unit of input. For demand-side measures, given the difficulties in their implementation and lag in their effectiveness, policy should be introduced quickly, and should aim to co-deliver to other policy agendas, such as improving environmental quality or improving dietary health. These problems facing humanity in the 21st Century are extremely challenging, and policy that addresses multiple objectives is required now more than ever (Smith, 2014).

Recent studies (Bajželj *et al.*, 2014; Tilman & Clark, 2014) have confirmed the need for dietary change and other demand-side measures to meet the climate mitigation challenge, and to address food security, and these results will also be reviewed.

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Special Plenary Keynote on

CSA Science-Policy Interface:

Bringing Findings of CSA Science to Policy-makers

Tuesday, March 17 2015

8:30–9:00

AUDITORIUM PASTEUR

08:30 Bringing findings of “CSA science” to policy makers

Allahoury Amadou

High Level Panel of Experts on Food Security and Nutrition (HLPE), Steering Committee Member
High Commissioner for Food Security to the President of the Republic of Niger

“Bringing findings of “CSA science” to policy makers” is an extremely important question. The High Level Panel of Experts on Food Security and Nutrition was faced with a similar challenge in 2012, when the UN Committee on World Food Security (CFS) asked it to prepare a Report on Food security and climate change in order to inform CFS’s policy debates on the issue (HLPE, 2012). To answer this very question, one needs to first answer three other ones: 1) What is “CSA science”? 2) “What” to bring to policy makers? 3) “How” to best do it?

1) What is “CSA science”?

As defined by FAO (2010), CSA is a way forward for agriculture, in order to ensure food security in a changing climate. Though the term CSA was not used in the HLPE Report, apart from the foreword, the HLPE Report shared, because of its focus on food security and nutrition (FSN), most of CSA’s orientations.

So what is CSA science? This is science that contributes to advancing knowledge for the three objectives of CSA: food security, adaptation, mitigation. This set of objectives is complex, and what is sought is science capable of addressing these objectives either altogether, or, when focusing mainly on one of them, in such a way that it can dialogue with the other dimensions. “CSA science” is characterized by a capacity to be understood by those adopting primarily another perspective, including in other settings, countries etc. For example mitigation science can become CSA science when it integrates food security concerns, or when it can be used by those whose primary focus is food security. Which includes challenges of methodologies, scales, time-span, metrics, readability, etc.

Overall, there is an issue of balance of CSA science as a whole. It needs to reflect the balance of objectives of CSA. This is a challenge because research and the research apparatus get focalized by disciplines, and because very often, researchers tend to see knowledge gaps as incremental gaps of current research. But we shall move away from CSA science being “more of the same” agriculture and climate research, just with a new label, or a new terminology.

CSA science should not be business as usual and in fact needs to address other kinds of knowledge gaps: “gaps in-between the disciplines and main areas, that are studied by no-one, but that needs to be studied”, and “gaps of understanding between disciplines”. This is what makes this conference so important.

Because CSA is meant as a “way forward”, CSA science should orient and ground concrete action. In doing so, it needs to be relevant to the wide range of stakeholders involved (farmers, private sector, and public actors national and international, civil society and NGOs), with a need for concerted and coordinated involvement and action of all these actors. CSA science needs to provide operational knowledge for all of them, including consider how to manage conflicting objectives, and the need to work on a long term perspective while most of the actors generally focus on shorter term outcomes as priorities. And, as some groups are more vulnerable than others, CSA should give special care to approaches that prioritize vulnerable communities, women and disadvantaged groups.

To do so, CSA research agenda and CSA science will require meaningful engagement and involvement from the start with farmers and the intended beneficiaries, and a genuine dialogue to understand their needs, taking into account the difficulties that can exist in obtaining the views of women and disadvantaged groups.

2) "What" to bring to policy makers?

Given the above, what are the relevant knowledge gaps which should be the focus of CSA science? Some of these knowledge gaps have been highlighted by the IPCC in its 5th assessment report (Porter *et al*, 2014), and most of them were also identified in the HLPE report of 2012.

This includes, inter alia, the need to: expand the focus of research beyond a limited number of crop and regions; assess neglected crops, fruit and vegetable productivity, "stress combinations" and the interactions between different abiotic and biotic stresses; pay closer attention to yield variability; focus on other aspects of the food systems connecting climate change to food security, than those related to production stricto-sensu; collecting more biophysical data to better understand the performance of current plant and animal genetic diversity under a range of agro-climatic conditions; understanding how to improve resilience to current variability and change, as one of the ways to adapt to future climate change; monitor existing practices, mitigation and adaptation interventions, and their performance on food security to ensure there are no unintended negative consequences; improve information about vulnerable communities/populations and regions; improve models that facilitate understanding of climate change effects on agriculture, and improve capacity building on the use of models and scenarios, including proper understanding of their limitations and uncertainties; organize regional sharing of experience and knowledge;

Many of those gaps have to do with the need to adopt much more multidisciplinary approaches to understand the impacts on food security, in its four dimensions: availability, access, utilization (nutrition) and stability, and the need to refocus research to address a more complex set of objectives.

3) How to best "bring science to action/decision"?

Therefore, beyond the issue of "what policy makers want", the real issue is "what stakeholders, and decision-makers need". The first is not necessarily equal to the second - while ideally it should be. CSA science should help bridge that gap between what stakeholders need and the priorities of policy making. It needs to support stakeholders, first of all the farmers, on the best possible action and providing the supporting knowledge. It needs to inform policy-makers on the best possible enabling environment.

The "how" should take into account the specificities of the issues, the current institutional settings, and the role of each stakeholder. It needs to take into account how current structures (including capacity building, extension) work in support to farmers. There is a need for concrete examples (even taken from other regions/contexts).

There is a need to create innovative mechanisms for science/policy dialogue at international but also at national levels. At international level, the HLPE and CFS is an example. Another one is the increased presence, in UNFCCC, of expertise and evidence, to which CSA science should contribute.

At national level, a good opportunity for this is the preparation of National Adaptation Plans and more broadly of FSN and/or CC strategies and programs. One example presented at this conference is the operational Dialogue between researchers and decision-makers for climate change adaptation in Mali.

The "how" should deal with the challenges to communicate with decision makers on climate change impacts and solutions to be implemented, particularly the need to accommodate local specificities and the ways to decide in a situation of uncertainty. Therefore "how to measure, assess and communicate uncertainties" is a fundamental dimension of the method. Also, another challenge is to adapt the language to the time frame of decision–makers. Each stakeholder has a different time frame: the farmer, the plant or animal breeder, the researcher. The dialogue between science and decision-makers, policies and institutions (including extension, the development of capacity building) for climate smart agriculture must take these time lags into account.

Finally, and perhaps the most important point, is that conveying a scientific message to stakeholders, needs, in its format and content, to enable common understanding between stakeholders. This is because decision processes, at political level, are more and more complex. The HLPE provides an interesting example of such science-policy interface to decision making, and to a decision making body, in the domain of food security.

There is a similar challenge, and perhaps the need for an ad-hoc interface, to make the link between the world of CSA science and research, with the stakeholders gathered in the CSA alliance.

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Plenary 3:

Key Questions for Climate-Smart Agriculture

Tuesday, March 17 2015

9:00–11:00

AUDITORIUM PASTEUR

9:00 Plenary Keynote P3.1: Resilience and adaptation

Adaptation, Resilience and Climate Smart Agriculture – from concepts to action

Meinke Holger[1,2], Baethgen Walter[3], Meza Francisco[4], Campbell Bruce[5]

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Issues such as 'sustainable agricultural production', 'food security' and 'climate change' are considered wicked problems, *i.e.* issues that are innately resistant to solutions and that will only ever be partly resolved. This is exemplified by agricultural practices that often lead to unintended environmental or social consequences due to complex chains of cause and effect. We argue that attempting to advance such issues through the further development of well-considered conceptual frameworks such as 'adaptation', 'resilience' or 'climate smart agriculture' is an important step to ensure rigour and robustness in our thinking but has limited practical application. If practice change is the aim, it might best be achieved through modesty ('a partial or temporary solution constitutes good progress'), honesty ('win-win solutions are rare; we must be honest about inevitable trade-offs') and courage (a willingness to make decisions in the face of uncertainty and unresolved contention). Many on-the-ground constraints are the consequence of imperfect value chains that lack good governance, transparency and equity coupled with imperfect market signals and knowledge systems. Transparency and increased knowledge dissemination throughout the food system value chain will change the dynamics of problems and can provide partial solutions along the way. We will highlight these issues by telling the story of two very different farmer groups: smallholder rice farmers on the peri-urban fringe in Vietnam and dairy farmers in Tasmania. While their socioeconomic and biophysical environments couldn't be more different, both groups find themselves as the instigators and the recipients of transformational changes. The examples will highlight why and how understanding their innate adaptive capacity, resilience and their ability to act 'climate smart' can help in improving these systems. We conclude that while business does not conform to theoretical paradigms, concepts such as 'entrepreneurship' and 'innovation' contain key elements of adaptation and resilience. Mutual understanding and a set of highly context-specific proxy indicators for academic frameworks can improve the transparency and governance of value chains, improve our knowledge systems and hence, lead to impact.

9:30 Plenary Keynote P3.2: Sustainable intensification and mitigation

Sustainable intensification and mitigation

Bustamante Mercedes M.C.

University of Brasilia, Brazil

Land provides food, fibre for a variety of purposes, and is a critical resource for sustainable development in many regions. Agriculture is frequently central to the livelihoods of many social groups, especially in developing countries where it often accounts for a significant share of production. The average amount of cropland and pastureland per-capita in 1970 was 0.4 and 0.8 ha and by 2010 this had decreased to 0.2 and 0.5 ha per capita, respectively. Changing land-use practices, technological advancement and varietal improvement have enabled an increase in world grain harvests between 1970 and 2010 while there has also been a 233% increase in global fertilizer use and a 73% increase in the irrigated cropland area.

Annual GHG emissions from agricultural production in 2000-2010 were estimated at 5.0-5.8 Gt CO_2eq/yr while annual GHG flux from land use and land use change activities accounted for approximately 4.3-5.5 Gt CO_2eq/yr. Agriculture, Forestry and Other Land Uses (AFOLU) activities lead to both sources of CO_2 (*e.g.* deforestation, peatland drainage) and sinks of CO_2 (*e.g.* afforestation, management for soil carbon sequestration), and to non-CO_2 emissions primarily from agriculture (*e.g.* CH_4 from livestock and rice cultivation, N_2O from manure storage and agricultural soils and biomass burning).

Mitigation options in the AFOLU sector need to be assessed, as far as possible, for their potential impact on all other ecosystem services provided by land. AFOLU mitigation options can promote innovation, and many technological supply-side mitigation options also increase agricultural and silvicultural efficiency. Increased land demand for GHG mitigation can be partially compensated by higher agricultural yield per unit area. While yield increases can lead to improvements in output from less land, generate better economic returns for farmers, help to reduce competition for land and alleviate environmental pressures, agricultural intensification if poorly implemented incurs economic costs and may also create social and environmental problems such as nutrient leaching, soil degradation, pesticide pollution, impact on animal welfare and many more. Maintaining yield growth while reducing negative environmental and social effects of agricultural intensification is, therefore, a central challenge, requiring sustainable management of natural resources as well as the increase of resource efficiency, two components of sustainable intensification.

Studies calculated potentially large GHG reductions from global agricultural intensification by comparing the past trajectory of agriculture (with substantial yield improvements), with a hypothetical trajectory with constant technology. However, increases in yield may result in feedbacks such as increased consumption ("rebound effects"). Agriculture and forestry related GHG mitigation could cost-effectively contribute to transformation pathways associated with long-run climate change management. The scope to reduce emissions intensity appears considerable since there are very large differences in emissions intensity between different regions of the world. Potential for improving emissions intensities lies especially in developing countries, if intensification strategies can be matched to local resources and contexts.

Combining efficient agricultural land use with biodiversity conservation is a significant concern. Since agricultural expansion is one of the drivers of deforestation (especially in tropical regions), one central question is if intensification of agriculture reduces cultivated areas and results in land sparing by concentrating production on other land. Land sparing would allow released lands to sequester carbon, provide other environmental services, and protect biodiversity. Recent analyses posed the question whether (or alternatively, at what scale) farming and conservation land management should be separated; segregating land for nature from land for production (land sparing), or integrated with production and conservation on the same land (land sharing or wildlife-friendly farming). Linking agricultural intensification with biodiversity conservation and food production requires well-informed regional and targeted solutions.

10:00 Plenary Keynote P3.3: Agroecology, soils and ecosystem adaptation

Agroecology *is* climate smart

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Agroecology is climate smart; but this is not equivalent to say that climate smart agriculture (CSA) is synonymous with agroecology. CSA has been defined as an approach to addressing food insecurity and climate challenges through: (1) sustainably increasing agricultural productivity and incomes; (2) adapting and building resilience to climate change; (3) reducing and/or removing greenhouse gases emissions. The first priority is perhaps the most controversial one, as it is subject to the way in which 'sustainability' is defined and measured. In climate-dominated debates both sustainability and environmental impacts tend to be assessed almost exclusively in terms of global warming potential. Rather reductionist indicators such as CO_2 emission equivalents per unit of agricultural produce are often used, masking (i) the actual performance of systems in terms of resource efficiency or generalised resilience, and (ii) non-climate related environmental impacts such as water pollution with agrochemicals or biodiversity loss. The impression is that almost anything, any technology or practice could be justified, as long as its CO_2 emission equivalent per unit of produce is low. Agroecology, on the other hand, is defined as the use of ecological principles for the design and management of sustainable food systems. Agroecology is not only a scientific discipline or set of practices; social organization is the key to the spread of agroecology among family farmers around the world. Agroecological systems follow the principles of diversity, resource efficiency, recycling, natural regulation and synergies. There is no prescription or certification standard, just principles, that translate into management practices adapted to specific contexts. I will present documented examples from around the world to show how agroecology contributes to the three priorities of CSA, particularly in the context of smallholder family agriculture, and discuss the potential of agroecological principles to guide the design and management of large scale farming as well.

10:30 Plenary Keynote P3.4: Food security and food systems

Climate-smart food systems

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Climate-smart agriculture is defined in terms of a set of outcomes from farming systems: improved agricultural productivity or food security, higher adaptive capacity and, where possible, reduced or removed greenhouse gas emissions. The actions needed to achieve these outcomes are most commonly conceptualised as a set of practices, technologies and services at the level of farms and farming landscapes. Yet a growing body of evidence shows that actions in agriculture and land use cannot, in isolation, achieve global aspirations for food security and low emissions development. Pre-production and post-production stages of the food supply chain can provide substantial, but under-researched, contributions to climate risk management, adaptation and mitigation, leading to the notion of climate-smart food systems. Identities provide a key means to link and analyse the components of a climate-smart food system. Demand-side factors, particularly dietary patterns and trends, may be more important that supply-side factors in determining long-term food security and environmental sustainability under climate change. Sustainable and equitable outcomes for human and planetary health are more likely if we seek changes in behaviours, norms and policies across whole food systems, rather than in climate-smart agriculture alone.

Special Plenary Keynote on Land Degradation and Desertification

Tuesday, March 17 2015

11:30–12:00

AUDITORIUM PASTEUR

11:30 The tragedy of the commons revisited: land degradation and desertification on public lands

Payne William A.

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When Garrett Hardin first introduced the concept of the Tragedy of the Commons in 1968, he used the example of a pasture "open to all" such that "Each man is locked into a system that compels him to increase his herd without limit--in a world that is limited." "Freedom in a commons," he wrote, "brings ruin to all." After giving many examples of tragedies of commons, including pollution and population growth, he returned to grazing on public lands in the Western USA: "Even at this late date, cattlemen leasing national land on the western ranges demonstrate no more than an ambivalent understanding, in constantly pressuring federal authorities to increase the head count to the point where overgrazing produces erosion and weed-dominance." Erosion and weed-dominance are of course components of the larger phenomenon of land degradation, defined by the FAO's Land Degradation Assessment in Drylands (LADA) as "the reduction in the capacity of the land to perform ecosystem functions and services that support society and development." The related phenomenon of desertification was defined at a 1977 United Nations Conference as "... intensification or extension of characteristic desert conditions; the process entails a reduction in biological activity and plant biomass, in livestock carrying potential of land, in agricultural yields and a decline or degradation in man's living conditions."

The drylands, where most desertification takes place, are vast, making up 40% of the world's land surface. Nearly one third of this is rangeland. Land degradation can take place in more humid areas as well. Although science has been able to measure many component processes of land degradation and desertification, such as erosion, on small scales for many years, the ability to assess land degradation on larger scales is only a few decades old. An early effort, GLASOD, assessed human-induced soil degradation through qualitative "expert judgments" at global or continental scales, and concluded that on a global basis, land degradation was caused primarily by overgrazing (35%), agricultural activities (28%), deforestation (30%), over-exploitation of land to produce fuelwood (7%), and industrialization (4%). GLASOD suffered from several limitations, including the inability to predict trends.

More recently, remotely sensed images taken over time have been used at large spatial scales, but with greater resolution. Using Normalized Digital Vegetation Index (NDVI) as an indicator, a recent study concluded that some parts of the world have slightly increased biomass over a 20 year period, whereas others have shown a small decline. The study further concluded that land degradation processes are on-going over a large part of the earth, and that most degradation was due to soil erosion and biodiversity loss in less populated areas. Another remote sensing study used the ratio of NDVI to net primary productivity (NPP) from 1981 to 2003, and concluded that some regions of the Earth were "browning," and others "greening." It found that ~24% of the earth's surface had undergone some degree of degradation, and that the suggestion that soil erosion posed a catastrophic threat to the survival of humanity was overstated. Our scientific understanding of the component processes of land degradation continues to improve, as do the resolution and affordability of remote imagery data. Today, various indicators of land degradation can now be assessed for free with various accuracy, including vegetation dynamics, surface crust formation and persistence, soil salinity, dust storms, and drought.

Simulation modeling offers another approach to assess land degradation on large scales. For example, the USDA Wind Erosion Prediction System simulates fundamental processes that control wind erosion. In addition to predicting soil erosion, WEPS can calculate soil movement, estimate plant damage, predict PM-10 emissions, and provide the user with spatial information on soil flux, deposition, and loss. Simulation models can also be very useful in assessing mitigation or land rejuvenation through changes in land management. For example, the

USDA's Natural Resource and Conservation Service has used the APEX model to quantify the effects of past conservation efforts on sediment and nutrient dynamics, and to recommend future land management practices. Their results indicate that U.S. farmers reduced total cropland erosion caused by wind and water by 43% between 1982 and 2007.

But despite our ability to better understand and monitor land degradation, desertification, and their various component processes, less is understood about the links between land degradation and climate change, and less still about how climate change and land degradation processes currently interact with different social-ecological systems around the world, or how they might interact in the future. Yet this understanding is key if we intend to not only better understand and monitor land degradation and desertification, but to also reverse these processes and achieve sustainable land use systems. Humans who depend on drylands for their livelihoods have developed coping responses over hundreds and even thousands of years of inter-generational learning. Traditional knowledge is therefore invaluable to discussions aimed at restoration or development of sustainable land use systems. Because land degradation and desertification typically have roots in human activities, addressing these roots will often require local action and societal answers. This, we believe, is why Hardin stated that problems that fall into the category of tragedy of commons have no technical solutions—instead, they require changes in human attitudes and behavior.

Systems-based research designed to reverse land degradation should therefore have as key components: Farmer communities and other stakeholders who are actively involved in problem definitions, research designs and testing of potential solutions to mitigate land degradation processes (participatory research); and scientists from different backgrounds, such as soil science, agronomy, ecology, socio-economics, who work together in project teams to tackle important research questions (inter-disciplinary research).

Our paper illustrates the Tragedy of the Commons, land degradation and desertification, and systems-based research as they relates to modern and historical rangelands in the U.S. West, and in particular in Nevada, the driest state in the U.S.A. Collectively 28% of the lands in the U.S. are in federal land ownership, but this ownership is concentrated in the West, and culminates in Nevada, where 87% of the land is managed by several federal agencies and administrative regulations. Public lands were intended to serve many public needs, including grazing of livestock, recreation, energy development, habitat protection, and wild horses. Competing views based on philosophical or emotional views rather than sound science have emerged among an increasingly urban population, and have led to several politically charged debates, all of which are intimately connected to agriculture, and include 1) water availability and quality, 2) wildfire management, including suppression, community protection, and restoration following widespread devastation from fires, 3) limiting and reversing encroachment of invasive species, and 4) managing for endangered species. All of these issues are contentious to the point that they are frequently litigated in federal courts, which offers a slow and expensive model for conflict resolution that doesn't attain the goals of sustainable land management. An alternative model is presented that is based on systems-based research that includes scientists, federal agencies, land owners, and diverse stakeholders, including environmentalists. The focus for the landowners, which own or lease 690 000 ha of prime sage-grouse habitat, is on-the-ground habitat projects, but also on long term collaborative solutions to reduce habitat-related conflicts. The group uses a landscape- and watershed-approach to land management, which includes several elements of indigenous or local knowledge.