

Climate Change, Agriculture and Food Security (CCAFS)
Challenge Program of the CGIAR

**Climate Change Adaptation and Mitigation in Agriculture
Science Workshop Report**

Playacar Palace
Playa del Carmen, Mexico, 1-2 December 2010



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I. Summary

CGIAR and partner scientists met in Cancun, Mexico, with the purpose to advance science on climate change adaptation and mitigation, according to the scope of the CGIAR program on Climate Change, Agriculture and Food security (CCAFS).

The objectives of the workshop were to (1) understand ongoing research as a foundation for future collaboration and advances, and (2) explore research that shows the highest promise for scientific breakthroughs.

II. Context

The program on Climate Change, Agriculture and Food Security, or CCAFS, brings together strategic research carried out by the CGIAR, the Earth System Science Partnership (ESSP) and

their respective partners in an innovative collective effort to be coordinated by the International Center for Tropical Agriculture (CIAT).

By 2020, the effort aims to reduce poverty by 10 percent in targeted regions, lower the number of rural people who are malnourished by 25 percent and help developing country farmers contribute to climate change mitigation by enhancing carbon storage and reducing greenhouse gas emissions by an amount equivalent to 1,000 million tonnes of carbon dioxide over a decade, compared with a “business-as-usual” scenario.

The launch of CCAFS marks the beginning of a long-term endeavor with an initial 3-year budget totaling US\$206 million. Much of its field work will begin in 2011, with an initial focus on East and West Africa as well as South Asia’s Indo-Gangetic Plain, regions that are especially vulnerable to climate change impacts.

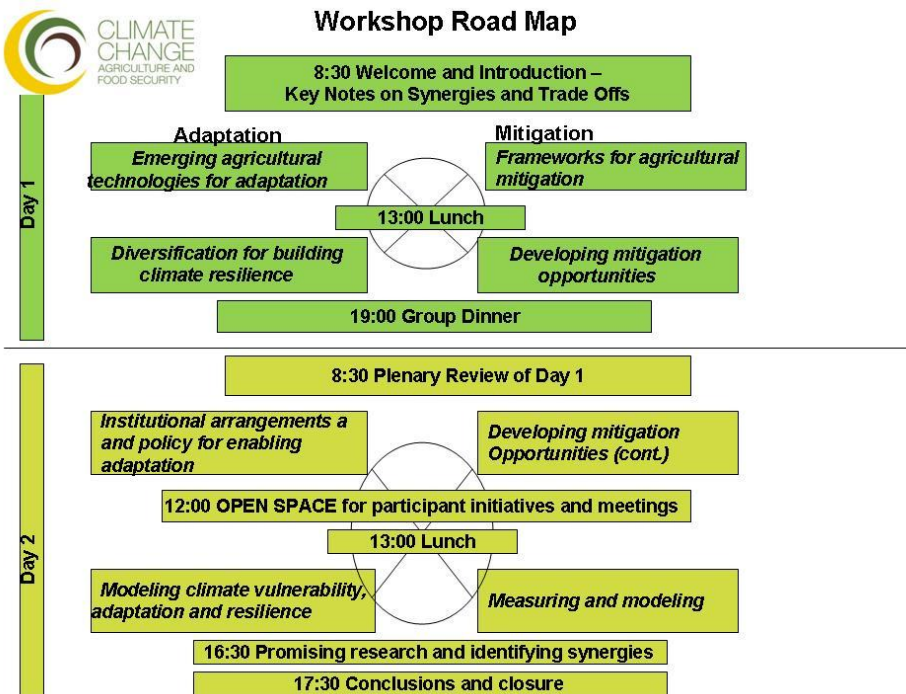
CCAFS partners will identify technologies and policies for climate change adaptation and mitigation that are suitable for poor, smallholder farmers and other rural people. Scientists will also refine models used to predict the impacts of a changing climate on agriculture and livelihoods, and identify ways to select hardier crop varieties and livestock breeds as well as novel farming and food systems that are suitable for future climate conditions.

III. About the workshop

Within this context the CCAFS team decided to start a series of science meetings (with an objective of at least one per year). The first in the series should assure productive engagement from all scientists who are involved and who haven’t had the opportunity yet to sit down together and talk about science. Indeed, after many months of proposal writing and administrative research planning it was time for the “doers” to come together, share their work and start to form a scientific community.

The workshop dealt with three of the four Program themes (see figure 2), mitigation and adaptation. In the workshop design it was decided to maintain two parallel session streams, one for adaptation and one for mitigation and combine those with short plenary sessions dedicated to summaries and analytical reflections.

Figure 1: The workshop road map



The workshop received two introductory talks: by Erick Fernandes from the World Bank entitled: Towards Climate Change Adaption and Mitigation: Synergies and Trade-offs; and by Simone Cook (consultant) on: A framework for adaptation and mitigation research.

Under the adaptation stream the sessions addressed the following topics

- Modeling climate vulnerability, adaptation and resilience
- Diversification for building climate resilience
- Institutional arrangements and policy for enabling adaptation
- Emerging agricultural technologies for adaptation

The mitigation sessions were structured as follows:

- Frameworks for agricultural mitigation
- Developing mitigation opportunities (two sessions)
- Measuring and modeling

The issues and ideas that came out of the mitigation and adaptation sessions were documented in format of cards which were then organized in form of a visual mind map posted on a meeting wall room.

Furthermore, the workshop offered an Open Space session, an opportunity for participants to self organize short 45 minute parallel session of topics of their interest, which generated an additional 5 sessions.

The event was organized by Lini Wollenberg, leader of the mitigation theme and her research assistant Alison Nihart of the University of Vermont, and facilitated by Simone Staiger-Rivas who is currently leading the capacity strengthening and knowledge management initiative of CIAT.

In a short one page evaluation of the workshop the objectives, content and process could be evaluated. The 21 responses show that the meeting objectives were very relevant for 16 participants but that they could have been clarified in more detail (only 10 said were very clear). For 4 participants the objectives were fully met, for 15 satisfactorily and for 2 not very well. The content of the workshop and the topics addressed were very clear for 13 participants and very relevant to the work of 15 participants. With regards to process, the facilitation was rated as very good by 15 and as satisfactory by 6 participants. The balance between presentations and discussions was evaluated as excellent by 11 and good by 8 participants. The logistical organization and coordination was excellent for 18 and good for 3.

IV. Workshop results

1. Plenary Key Notes

Thomas Rosswall is the Chair of CCAFS Steering Committee and kicked off the meeting with contextual contributions that highlighted the big disconnect that appears when we look at how development and global change have been addressed, researched, and funded as unrelated issues. The main challenge that Rosswall highlighted is about “asking for a wide range of agricultural sector actors to change their behavior, to innovate, under conditions of incomplete and un-integrated markets, asymmetric information & missing insurance and credit markets.”

Bruce Campbell, CCAFS Director, summarized for the participants the four research themes that constitute the program’s research agenda:

Figure 2: The four CCAFS research themes

Theme	Objective
1. Adaptation to Progressive Climate Change	1.1 Adapted farming systems to changing climate conditions
	1.2 Breeding strategies for future climatic conditions
	1.3 Species and genetic diversity for climate change
2. Adaptation through Managing Climate Risk	2.1 Managing climate risk and building resilient livelihoods
	2.2 Managing climate risk through food delivery, trade and crisis response
	2.3 Prediction of climate impacts, and enhanced climate services
3. Pro-poor Climate Change Mitigation	3.1 Low-carbon agricultural development pathways
	3.2 Institutional arrangements and incentives for mitigation
	3.3 On-farm mitigation practices and landscape implications
4. Integration for Decision-Making	4.1 Linking knowledge with action
	4.2 Data and tools for analysis and planning
	4.3 Refining frameworks for policy analysis

World Bank's Adviser on Natural Resource Management and Climate Change, Erik Fernandez shared concrete examples of local to global impacts of land cover and land use changes that are impacting and impacted by climate variability and change.

He also stressed climate change as an opportunity for economic and social transformation that can lead to an inclusive and sustainable globalization and highlighted CCAFS' comparative advantage in summarizing, synthesizing, and making accessible the considerable CGIAR knowledge on improved technologies for adaptation and mitigation as well as its role in supporting decisions for Policy Makers and synthesizing spatially relevant knowledge for harnessing dynamic adaptation-mitigation synergies and minimizing tradeoffs in agroecosystems.

Simone Cook, a currently independent consultant and previous staff of CIAT and the Water and Food Challenge Program (CPWF) underlined the need to base CCAFS work on a framework for adaptation and mitigation and suggested one that on the basis of existing knowledge of likely impacts looks for: 1) behaviours that inhibit/support change -attributable to global climate change, 2) scans for institutions – the people doing the changing, 3) looks for 'instruments' of change- things that will accelerate adaptation & mitigation, like insight, technologies, policy, law and 4) identifies how science will support /improve the instruments.

2. Open Space Discussions

The workshop offered an Open Space session, an opportunity for participants to self organize short 45 minute parallel session of topics of their interest, which generated an additional 5 sessions:

1. Adaptation & Mitigation Framework (Simon Cook, consultant): The session aimed at collecting some ideas for case studies that could help in trialing the framework that Simon Cook presented as a key note during the introductory session of the workshop
2. Diversification as a CC adaptation strategy (Laura Snook, Bioversity): Includes genetic, crop, farming system diversification incl. tress, crops, livestock, fish. The Need to start with a critical literature review was discussed and the need for site specific data gathering. The session led to a series of inputs that will allow to put together a concept note.
3. Special issue of IPCC (Bruce Cambell, CCAFS Director): The session aimed at gathering ideas for a special issue of IPCC based on CCAFS competitive advantages. The group gathered 8 topics: 1) Diversification for CC; 2) Synergies / trade-offs; 3) Pathways for development; 4) Social and economic impacts of mitigation and adaptation; 5) Sustainable intensification as a mitigation strategy; 6) Water interventions for adaptation; 7) Implications of mitigation on water; 8) Underlying drivers of food security; 9) Vulnerability of food systems livelihood; 10) Access to genetic diversity for CC adaptation (seed systems / analogue adaptation); 11) Synthesis of technical options for mitigation; 12) Scenarios at regional level; 13) Incentives for climate smart agriculture.
4. Resilience and ex-ante modeling at HH level (Jim Hansen, CCAFS and Columbia University): This session addressed questions on how to make decisions now about an uncertain future of stochastic shocks... how to bring together different factors in a probabilistic model? Can we do it at a HH level?

5. Emissions factors for farming practices (Lydia Olander, Duke University) invited interested participants to try to understand data needs and gaps for models in developing countries

V. CCAFS planning meeting

A post workshop meeting allowed some 20 CGIAR staff to get more information about CCAFS future structure and operational mode, and to narrow down the 150 issues and ideas raised during the workshop to 9 issues considered relevant and of particular interest to the participants who signed directly up to the topic of their concern. Those issues relate to: 1) Intensification; 2) Diversification / Intensification; 3) Breeding; 4) Impact of CBD / adapted germplasm; 5) Adaptation and mitigation synergies; 6) Adaptation; 7) Integrated analysis; 8) Mitigation potential; 9) (Ex-ante) evaluation of adaptation (see full list in annex).

The group also undertook a short but critical analysis of the previous 2 day event. Among the ideas that emerged where the need to structure at least partially the next workshop along some cross cutting adaptation and mitigation themes in order to allow a higher level of cross fertilization among both streams. It was also suggested to ask some speakers who work in related areas to prepare presentations together so that their talks reflect some collective thinking and therefore more progressive ideas.

Finally the group was informed that potential outcomes of this meeting would be an editorial in Science, a CCAFS report / working paper and a journal article. Several participants signed up to collaborate on those pieces of work.

Annexes

Annex 1: Agenda

Tuesday, 30 November

18:30 *Welcome reception* (outdoors)

19:30 *Dinner*

Day 1 - Wednesday, 1 December

Plenary Session

8:30 **Opening and introduction to CCAFS**

Thomas Roswall, Chair CCAFS Steering Committee

Bruce Campbell, Director, CCAFS

9:00 **Introduction to workshop**

Lini Wollenberg, CCAFS

9:30 **Synergies and trade-offs**

Erick Fernandes, World Bank

Towards Climate Change Adaption and Mitigation: Synergies and Trade-offs

Simon Cook, CIAT

A framework for adaptation and mitigation research

10:30 Break

Day 1 - Wednesday, 1 December (cont)

11:00 **Parallel sessions**

Adaptation	Mitigation
<i>Emerging agricultural technologies for adaptation</i> <ul style="list-style-type: none">• David Rosenthal (U Illinois, Urbana Champaign): Crop fertilization in a CO₂ enriched world: Is it good to be C3?• Vladimir Smakhtin (IWMI): Emerging water management technologies suitable for adaptation• Reiner Wassman (IRRI): Adapted rice crops for a 2030 world	<i>Frameworks for agricultural mitigation</i> <ul style="list-style-type: none">• Rodel Lasco (ICRAF): Lessons learned from Rewards for, Use of, and Shared Investment in, Pro-poor Environmental Services (RUPES)• Mohammed Asaduzzaman (Bangladesh Institute for Development Studies): Mitigation in Bangladesh's National Climate Change Action Plan and priorities for research• MarjaLiisa TapioBistrom (FAO): A framework for agricultural mitigation based on mitigation as a co-benefit and the MICCA project

13:00 Lunch

14:30 Parallel sessions

Adaptation	Mitigation
<i>Diversification for building climate resilience</i> <ul style="list-style-type: none">• Mirjam Pulleman (Wageningen University): Biodiversity and climate resilience• Laura Snook (Bioversity Int'l): The role of agricultural biodiversity at the genetic level in adapting to climate change	<i>Developing mitigation opportunities</i> <ul style="list-style-type: none">• Reiner Wassman (IRRI): Modifying water management for rice production• Ivan Ortiz-Monasterio (CIMMYT): Conservation agriculture in wheat and maize and latest science on no-till• Eddie Allison (World Fish): Low carbon animal protein? Life-cycle analysis of small-holder aquaculture value-chain• Jim Gockowski (IITA): Cocoa intensification and impacts on the forest resources

16:30 Break

19:00 Group Dinner

Day 2 - Thursday, 2 December

8:30 Plenary Session – Review and discuss Day 1

9:30 Parallel sessions

Adaptation	Mitigation
<i>Institutional arrangements and policy for enabling adaptation</i> <ul style="list-style-type: none">• Heike Schroeder (Oxford University, ESSP): Earth systems governance (<i>cancelled</i>)• Eddie Allison (WorldFish): The costs of adaptation in the aquaculture sector of Vietnam• Andrew Mude (ILRI): Building climate-resilient livelihoods through index based insurance	<i>Developing mitigation opportunities (cont.)</i> <ul style="list-style-type: none">• Henry Neufeldt (ICRAF): Rewards for mitigation• Mario Herrero (ILRI) Opportunities in livestock systems and trade-offs?• Christine Negra (Heinz Center): Lessons learned from REDD• Alex de Pinto (IFPRI): Mitigation opportunities and challenges: an economic perspective

11:30 Break

OPEN SPACE for participant initiatives and meetings

13:00 Lunch

14:00 Parallel sessions

Adaptation	Mitigation
<i>Modeling climate vulnerability, adaptation and resilience</i> <ul style="list-style-type: none">• Richard Washington (University of Oxford): Modeling livelihood vulnerability in Africa (<i>cancelled</i>)• Mario Herrero (ILRI): Household vulnerability assessment for rural livelihoods in East Africa	<i>Measuring and modeling</i> <ul style="list-style-type: none">• Lydia Olander (Duke University), Quantifying Agricultural Greenhouse Gas Mitigation with Process Models• Lou Verchot (CIFOR): Applicability of current process-based models and emissions measurement techniques to mitigation among smallholder farmers in developing countries• Roberto Quiroz (CIP): Emerging techniques for measuring soil carbon contents and stability

16:00 Break

16:30 Plenary Session –Promising research and identifying synergies

17:30 Conclusions and closure

19:00 Group dinner

Annex 2: Participants List

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Annex 3: Ideas and issues from the adaptation and mitigation session

Mitigation

Systems and trade-offs

- What is elasticity of avoided deforestation from alternative investments in rural productivity?
- Examine how the increase of agricultural productivity can decrease emissions from deforestation / degradation
- What is the role of fire? 1) Environmental services, 2) Cost / benefit / trade-offs between mitigation and environmental services
- What are biomass trade-offs for mixed livestock agricultural systems (plus landscapes)?
- How to make systems more efficient in H₂O, fertile. Tie to advanced resource management. Document for policy makers
- How can we develop integrated food-energy systems that decrease C.? How to trigger transformations?
- How to optimize across food/water/energy security, low C-goals? Tools to develop and evaluate. How to create self-reinforcing interventions?
- Soil Water interactions: Sludge in aquaculture for fertilizing of soils. Amazon run-off / soil erosion to waterways
- Learn from past experiences about achieving environmental aims in food systems: Mitigation is necessary. Agriculture cannot run away from its environmental responsibility
- Interactions between mitigation practices and land uses, e.g. H₂O, CH₄, +N in rice, all GHG's, Fish – rice, soil conservation, aquaculture
- What systems give highest mitigation benefits? Restoration of grasslands? Peatlands? Agroforestry?
- Need for multi-currency approach to trade-offs among efficiency, equity and effectiveness in incentive schemes
- Social and economic impacts and integrated analysis of mitigation
- Link mitigation interventions back to livelihoods
- What are the trade-offs of the increase of GHG emissions v. environmental services from fire?
- How to minimize net emissions from food systems?
- How to maximize the Carbon in the landscape
- Emphasize crop-livestock systems (biggest agricultural land use)

Incentives / Economic feasibility

- Policy level
 - Should we bother with agricultural mitigation? Will economics be worthwhile? Will people (smallholders) adapt and benefit? Compared to LUC and forests

- What are the costs and benefits of moving climate-smart agriculture?
- In which sectors / management practices I investment in mitigation likely to have the largest pay offs?
- Tools to identify where investments should occur across sectors and practices
- Document how the decrease of inputs and increase of yields from mitigation reduce costs for policy makers
- Compare potential incomes / finance and costs of mitigation programs prepared with national budgets. Is mitigation worthwhile invest in?
- How can carbon finance be used for investments in rural development (not just paying individual farmers) to create rural infrastructure
- If low productivity underlies poverty and land use change (deforestation/degradation) does sustainable intensification provide a priority strategy for both poverty and climate mitigation?
- Where are the banks / exchanges to manage payment?
- National level planning and evaluation tools for full range of options for directing resources to actors who can mobilize agricultural transformation
- If carbon prices are not high enough for farmers, are they high enough for institutions?
- Address complexity of payments. Successional scheme for PES
- How will bundled environmental service payment work? Efficiency versus complexity, measurement difficulties, monetization more difficult
- Farmer level
 - Examine related incentive based projects used in the past to understand elements that are useful in mitigation, e.g. contests in Peru
 - Test different incentives for farmers: Contingent subsidies, institutional bidding need to show benefits, price premiums, reduce transaction costs
 - What is the efficiency of payments to farmers? How to improve efficiency by targeting farmer groups, developing mechanisms between U.S. conservation reserve system payments
 - Payments to smallholders have failed. Are productivity gains not sufficient to compensate farmers?
 - What kind of collective action and governance needed to ensure benefit flows?
 - Don't just focus on payments. Focus on transformation into productive systems that are sustainable
 - How to make technology more attractive to farmers?
 - What institutional arrangements are needed to overcome no-till / conservation agriculture adoption?
 - Crop-livestock systems
 - What is the role of uncertainty and risk on incentives for mitigation
 - How can we save money by targeting the right payments to the right farmers?

- Which is better: Pay by adoption of practice (easy but inefficient) or by “CRP” (matches cost with payment but data intensive)? Is there something in between?

Data and Technology

- On-farm sequestration potential still need testing
- Need to test the presumed large potential for mitigation via agriculture
- Test avoided soil degradation concept (rather than increase soil OM, protect what is there).
- Synthesis technologies across CG and translate for policy makers
- Need for platforms / frameworks for data on: Net emissions / factors esp. packages of practices, drivers, management
- What are emissions factors for different practice packages? E.e coffee w/ shade, fertilizer. Do Life cycle analysis LCA's.
- Need more data on Carbon sequestration v. GHG emissions. Understand potential of pastures / forests and landscapes for net emissions.
- What kind of data systems are needed for ag mitigation?
- Potential contribution to global standards for ag mitigation
- How to fund MRV institutions and ensure acting is accurate enough to meet demands of international payment schemes?
- Better process models.
- How to do MRV effectively and what tools?
- Need standardized repeatable process without bias. Process for handling uncertainty
- Research on management practices to test models
- Comparison of different soil C measuring techniques, strengths and weaknesses
- Mechanistic understanding of what produces GHGs and variability
- Disaggregated climate information, so weather data for different regions can be standardized: publish on the Web and, to enable comparison

Measuring and Modeling

- Collect different stories from production systems to illustrate synergies and trade-offs
- Use models for the tropics
- Links to policy: Contribute to national communications on mitigation which must be improved
- MRV as a research agenda
- Monitor productivity for land use change
- Potential of deep rooted crops
- Carbon sequestration in grasslands: How to tap sequestration potential?
- Synthesis of models that are appropriate for developing countries (use an ensemble of models)
- Standardization of measurement techniques to get consistent / minimum datasets

- Soil sequestration as a mitigation strategy, associated with tropical wetlands; reducing erosions

Drivers

- Shifts in diets: fish-meat, types of fish, nutrient implications
- Family planning
- Population control
- Poverty dynamics; Rural-urban migration; agricultural labor

Opportunities (various)

- Role of agro-business
- Demand side of mitigation – bankers, investors
- Need to show up at negotiations
- Inform negotiations to make pro-poor outcomes

Intensification

- Unravel agricultural expansion. Links to land use change: co-dependence of certain crops on forest ecosystems; road building
- What are the incentives and opportunities for mitigation on degraded lands
- Do a typology of intensification
- How to achieve fire-free intensification?
- How to move beyond the current paradigm of intensification, e.g. deforestation decreased in the Amazon due to stop of landing from banks and to make it illegal to use to use illegal forest products
- Indirect effect on intensification, e.g. road infrastructure enables higher prices so invest in fertilizers, CR fiscal policy trade etc
- What are sustainable intensification schemes, what are their limits, indicators of transitions

Adoption rates and factors influencing

- Need to refine LCAs
- Global inventories of mitigation potential
- Scenarios of consumption
- Need for a global model on land use change (market will not yield results alone)

Adaptation

NRM

- New water technology, desalinization
- Exploit ground-water as a reservoir and buffer, continuum of storage options
- Study role of tress / AF in enhancing resilience under extreme events
- Explore eco-systems based adaptation (EBA)?

- CA and Tillage
- Rangeland rehabilitation and its potential for carbon sequestration

Climate info

- Evaluate approaches to reconstruct historic climate
- Interpreting climate projections, characterizing uncertainty at scale of adaptation decisions
- Spatial distribution of changes, stresses to inform genetic and technology development and targeting
- Improve resolution of spatial analysis of change to inform adaptive management

Diversification

- Research intensification versus diversification and alternate models (biological versus economic) for diversification as adaptation strategies
- Capture under exploited genetic diversity sources for strategic crops
- Increase attention to perennial, forage species for future climate
- Horticulture: Medicinal and Herbal plants; Fruit trees
- Crop livestock integration; value adding

Genetics

- Breeding, biotechnology to optimize photosynthesis for elevated [CO₂]
- Breed rice for resilience to draught, submergence, heat of flowering, salinity
- Introduce more efficient RUBISCO into crop germplasm
- Do we need special crop varieties for no-till systems?

Adaptive Frameworks

- Balance perspective on climate change to adapt by exploiting favorable conditions
- Experimental methodologies to test the impact of adaptation policies and strategies
- Evaluate adaptability of systems beyond component technologies
- Learn to factor level of uncertainty of future climate into technology development
- Understanding institutional constraints to adaptation and adaptive research with stakeholder involvement
- Help organizations of all levels adapt for adaptation
- Adapt to adaptation

Institutions and policies

- Income and livelihood diversification, agric and non agric.
- What drives farmer decisions? How can climate adaptation orientated actions contribute to making them better informed?
- Insurance could provide incentives, including possibly combined adaptation and mitigation. How could relevant institutions be encouraged to collaborate to foster synergies between mitigation and adaptation

- How can CC funding be channeled to planned adaptation investment?
- Should CCAFS work on risk insurance? Yes! It is under researched. Focus on landless poor with common pool resources. Maybe more cost efficient than disaster relief. For data poor areas. Insurance as reward and incentive for risk reducing behavior / adaptation / climate proofing
- How does one take into account autonomous adaptation?
- Alternate ways of defining uncertainty (i.e. the ‘when’ not the ‘if’) with regards to vulnerability; for decision making (researchable questions)

Adapting / Modeling

- Increase use of household ex-ante modeling for adaptation options
- Address possible cross-sector trade-offs among adaptation strategies
- Move from indicator-based to more integrated food system vulnerability assessment
- Modeling frameworks for different types of uncertainty (metric, temporal, structural, translational)
- Products (e.g. insurance premiums) that encapsulate complex information
- Research translating model results into actionable information decision support for a range of decision makers
- Challenge of communicating uncertainty with decision makers
- CGIAR process for linking research results to policy and practice
- Research on how to influence policy

Let’s see

- Common baseline info and criteria for targeting adaptation strategies
- Consider uptake when developing adaptation technologies
- Synthesize and build on past research when developing technology for adaptation.

Synergies

- Adaptation-mitigation landscapes: Understand nutrient flows; optimize Carbon content
- What are the synergies between adaptation and mitigation?
- What are the common local level governance structures and institutions that avoid adaptation and mitigation practices?
- Link products to the IPCC ARI process
- For whom? International -> UNFCCC, CC. National -> ministry; Local ->...
- Understand and quantify water and land implications of mitigation interventions, e.g. of forestation, biofuels
- Identify the entry points or incentives for adoption of adaptation and mitigation

- Potential for biodiversity to contribute to both adaptation and mitigation (e.g. reduced fossil fuel)
- Trends in soil Carbon loss, opportunities in avoided soil carbon loss
- Potential for deep rooted crops to mitigate or adapt to H₂O stress
- 20 stories of adaptation and mitigation synergies. Trade offs e.g. Peru: Shift in Potato cultivation result in land use change and increased emissions
- Fertilizer GHG Plot level versus landscape level
- Carbon finance
- PES to look at Carbon finance
- Work on truly orphan crops (Crops for the Future)
- How to best communicate between mitigation and adaptation
- Energy-agriculture nexus
- Integrated food energy systems “M-A synergy”

Annex 4: Session Notes

Plenary Sessions

Wednesday, December 1

ERIK HENDERSON and SIMON COOK

- Importance of admitting uncertainty (e.g., accompanying those numbers with Ecocrop predictions), showing projections for both short term and long term, translating those for politicians
- Water deliberative politics: contributing to discussion, making it transparent
- Potential for intensification (nutrients, nitrogen fertilizers), closing yield gap (crops) by utilizing best management techniques, managing livestock
- How to ensure correct technology linkages to development on ground? – answer is think about landscapes, develop tools for evaluating potential in future, but also examine past to decide where to utilize technologies and where/how to preserve traditional ecosystem landscapes

Thursday, Dec 2: afternoon

Mitigation (morning) – Lini’s summary

- effects on uncertainty and risk on incentives
- multi-currency tradeoffs on adaptation, mitigation
- integrated analysis (including SES), linking back to livelihoods
- refine lifecycle analyses (LCAs)
- sustainable intensification
- how to influence negotiation? Presence to find sticking points and research into how to un-stick them
- pro-poor mitigation

Adaptation (morning) – Laura’s summary

- Uncertainty, esp. re: time scales – how to defn it
- Vulnerability
- Autonomous adaptation – “dumb farmer” idea is a bad baseline, but how to take auton adaptation into acct? need for research into understanding how farmers adapt and what drives farmers’ decisions
- Risk insurance as under-researched – re: pastoralists/landless poor, data-poor areas, incentive mechanism for climate-proofing/synergistic best behaviors
- Challenging CC funding mechanisms to proper planned adaptation at right time

Mitigation (afternoon) – Lydia’s summary

- Case studies to examine synergies
- Soil carbon – how realistic? And what are priorities (wetlands)
- Store soil carbon at depth – also provides nutrients
- Consistent minimum data sets
- Developing process models for use in dvlping countries
- MRV – current emissions trajectories at national level
- Soil carbon sequestration in grasslands
- Ensembles for models and data needs
- Informing the process of national communications and creation of mitigation plans

Adaptation (afternoon) – Jim Hansen’s summary

- Capturing uncertainty
- Component modeling at HH level
- Vulnerability indicators/assessments at systems level, too ad hoc in past
- Qs of communication and relevance – how to communicate uncertainty and results to decision-makers in a way that doesn't inhibit action
- Reconsider CG institutional practices to ensure that research is linked to action
- Products that can encapsulate information that creates incentives for beneficial behavior

“Open Space” Discussions

-*Framework (Simon Cook)*

- get case studies to trial the framework (now have 6-8)

-*Diversification (Laura Snook)*

- need site-specific data gathering as case studies
- (missing notes)

-*Special issue of IPCC (Bruce)*

- 8 synthetic product ideas to pursue (ask Simone for list)

-*Resilience and ex-ante modeling at HH level (Jim Hansen)*

- how to make decisions now about an uncertain future of stochastic shocks... how to bring together different factors in a probabilistic model? Can we do it at a HH level?

-*Emissions factors for farming practices (Lydia)*

- trying to understand data needs and gaps for models in developing countries

What other synergies?

- Diversification
- Carbon finance
 - Payments for environmental services (few billion dollars available now, Norwegians)
 - Esp impt given rural-to-urban migrations and increasing pressures on ecosystem services
- Orphan crops (peach palm, et al.) that were food crops in the past
- Integrated food energy systems (energy security for farmers + mitigating potential)
- Fertilizer GHGs – plot level vs. landscape level

Tradeoffs: potato story (improving production comes at cost of emissions)

Breakout Sessions

Wednesday – Mitigation Session I

Rodel Lasco presentation

Maisa – tenure rights – FAO consultation 2 wks ago. Only 80% of area tenure rights(?) We have to develop some models of security of rights for individuals and communities.

Rodel – Philippines exception. 20% land in community forest.

Moushumi – more detailed research on governance – collective action. Smallholders working together may qualify if they work together.

Lydia Olander – connections b/t afoal and REDD – what are drivers for deforestation? Are there activities on Ag side that would reduce deforestation?

Rodel – beyond ag – industry develops

Bruce – looking for the big strategic emphasis. If C is such a pittance, why focus on C markets?

Rodel – Small study to quantify the potential for C credits in forest, compared to budget for forest management. To determine whether it is worth it. Dollar amount on potential is single most important piece for policy makers.

Lou Verchot –size of markets exceed current flow of budgets for rural areas. We need to think about other models on how C models can flow.

Christine – broaden scope of research beyond project - institutional econ, governance issues

Erick – WB helping Costa Rica w/ agrosilvicultural scheme – develop a region in a way that is aesthetically pleasant. Came up with GEF concept whereby farmers could reforest and be compensated based on an index determined by C value. Worked to create massive change. \$15-25/ha. When GF fund ran out, went to minister of finance, who wasn't interested in C. Intervention had increased production, which was well-documented, and he was interested in providing funding for this. C becomes icing on cake.

Henry – Trees on farms are something we want for co-benefits. If delivery of C market means farmers receive money at later stage, that won't work – farmers need the money when they make the change. We need to invert the payment structure. We have this in Ag systems to pay for crops that haven't been planted yet. C market can be strong catalyst, but C is not what it is about for the farmers.

Jim G – agree with Lou and Erick, given the importance of Ag in overall C cycle, (1/3 of global emissions) and given high transaction costs for paying ind. Farmers, question becomes what kind of avoided emissions do we get for investments in ag research or extension or rural infra that lead to productivity gains. This is what CCAFS is about, which is food security and environment. So research question in part is what is the elasticity of that avoided deforestation or degradation from alternative investments, where investment is not into some intervention to get more C on the farm, but to increase the overall productivity.

Asad presentation.

Bruce – ppt hits on one development pathway. Bangladesh has done a fantastic job to understand the tradeoffs and synergies. Would be great to get these studies in other questions. How to tweak subsidies to change pathway is a great questions.

Lini – in many countries, Ag is not included in low-C plan. Was it difficult in Bangladesh?

Asad – trust fund that funds research. We are trying to do projects in specific ecological settings instead of large scale research. Cutting edge research needed is in Bangladesh setting is... Difficult to convince policy makers that something bad will happen. Trying to push a more holistic view. Challenge right now is with Minister of Ag in Bangladesh.

Christine – building capacity, tools for developing and optimizing

Maisa presentation. We need practice-based emission factors. Practices can be monitored.

Reduce transaction costs – use existing contract systems, certification systems, we could create a C-smart brand. Bundled contract for various ecosystem services. Best way to get funding to farmers is through better price for products.

Wednesday – Adaptation Session I

Note: The notes below are only about questions/discussions following the ppt presentations.

David Rosenthal (U-Illinois, Urbana Champaign): Crop fertilization in a CO₂ enriched world: Is it good to be C₃?

- Other interacting factors other than CO₂, how does it interact?

- Water stress
 - DryFACE – co2 doesn't ameliorate productivity underground (e.g., bc allocation, et al)
 - Desert: drought is more important than CO2
- Temperature: soybean already basically at height of productivity, can only go down from here
- Ozone: CO2 ameliorates negative ozone effect
- Real world applicability for *cassava* experiment (Africa: cassava grown in areas where nothing else will grow)
 - True! In experiment, cassava was treated like corn crop, highly fertilized
- Interaction of CO2/Rubisco with altitude, crops domesticated under certain CO2 conditions, temperature – need for testing in other areas
- PARTNER POTENTIAL/ongoing research: Matthew Reynolds – leading a consortium for improving Rubisco efficiency (focus on wheat yields)
- Let's talk about the big push to engineer C4 rice!
- Examining thresholds – ongoing research on ozone on global level

Vladimir Smakhtin (IWMI): Emerging water management technologies suitable for adaptation

- Unanticipated consequences, e.g. of biofuels
- Not just quantity but quality of water in aquifers
- Schemes to improve management of flows (e.g., payments for ecosystem services?) – yes such schemes are in place, e.g. in SE Asia but they are relatively new
 - Andean region = ~\$20 billion/year potential for ecosystem services
- Potential for groundwater as adaptation mechanism (it's completely underexploited in Africa... and when it IS used, it's for household use rather than for agriculture → could build irrigation around it)
 - And where GW is (over)exploited, you can always replenish it
- “Green water”
 - Is this a good term?
 - “Recharging” water supply via rainfall capture — can be used to replenish GW
 - going beyond “blue water”?
- Water security
 - How to define it?
- Measuring water demand for diff areas
- Stop thinking about water as a necessarily finite source for which we need to therefore need to push water productivity. Instead think outside the box about utilizing technologies for non-traditional water sources
- How to make sure groundwater reserve management wouldn't just be neglected, as with other water storages in the past

Reiner Wassman (IRRI): Adapted rice crops for a 2030 world

- African rice (e.g., upland rice – more resistant to drought) = example of biodiversity to take advantage of

- Aerobic rice as method of lessening water use
- CC is about the interactions – Must think about combining SEVERAL traits/resistances into a single crop
- In addition to sea level rises, there are sinking deltas (bc inadequate sediment floors) – let’s think about tradeoffs and managing/scaling up technologies and applying them to the appropriate areas
 - ...and about “no-regret” management strategies
- What about geographic shifts as adaptation strategy?
 - Status quo is that this hasn’t happened as a CC adaptation strategy... migration more effects of urbanization/other human processes?
 - Fishing will be affected
- Shrimp farming as diversification technique, where inundation and salinity increasingly become the norm?
- Technologies for improving resistance: completely developing C4 crops might not be possible within this lifetime, BUT maybe transforming a C3 plant might be possible (if we throw enough money into it? But not within the decade?)

End Discussion – recurring themes, overall/other ideas, etc.

- C4 crops
- Groundwater
- How to keep robust any discussions of or research on interactions /appropriate complexity
- Synthesis and regional focus – creating priority areas (while taking into consideration all the variables)
- How to get technologies adopted (transforming knowledge to action) → stock-taking, imbedding CCAFS research that links with much more varied partners
 - E.g. implications of subsidies
 - Look at farmers’ practices, not just technologies
- Role of perennial crops
- Pastureland
- Thinking about food security in terms of preference/luxury too – if our food supply is being used for livestock feed, that’s not really a lack of sufficient food but a possible misallocation of it to provide for specific “luxury” preferences?
- Spatial resolution, downscaling models – harness technology better

Wednesday – Mitigation Session II

Reiner Wassman presentation

Peter Laderach – these are high input systems. What is situation when using organic matter?

Reiner – depends on quality of organic matter. If decomposition occurs before application, emissions are not high. Opportunity to use compost from biogas plant.

Ivan – CIMMYT has been asking IWMI to work on a aerobic rice. What would happen to emissions?

Reiner – Methane would go down. Nitrogen would be higher, question is how much higher. Depends on conditions and context.

Alex – are there similar dramatic effects in terms of delaying nitrogen applications by one day in terms of yields?

Reiner – More efficient use of Nitrogen reduces emissions. Key is site-specific nutrient management.

Jim – Economics: what is the net emissions gain? Could this be included for a payment for a change in management?

Reiner - 2.5 tons/ha, substantial enough to look into. CDM is really tricky. System is not useful – it is emissions/ha instead of emissions/production, which would get at the efficiency issue. A new methodology is being submitted to the UNFCCC.

Bruce – What are the big strategic issues we should be looking at?

Reiner – measurements are main message. Also, the technology is there, but we need to make it attractive. A funding scheme could bring the implemental costs that are needed to make it happen.

Lini – looking at all GHG and understanding how they interact is important.

Henry – better models is very important. Either statistical or mechanistic. We need to get away from measuring.

Erick – Compressed urea for reduced emissions?

Reiner – not sure if it can ben used at a larger scale.

Erick - Water management – communities are looking at low level irrigation. No standing water above surface. Reporting 40-60% increases in yield. Are you tracking that?

Reiner – No doubt that good management is improving yields, however the key Is looking at balance approach. We need to be realistic.

Ivan’s presentation.

Erick – data on C seq – did they account for soil texture (clay content?)

Ivan - Don’t think so

Erick - That’s very important. Correlation is higher with clay content than land use. Also, in Global Warming Potential system, no tillage may have a greater benefit than you indicated.

Mario – How to reconcile need for feed with fact that you may need to leave residue in the soil?

Ivan – You don’t need to leave 100% of residue. Trying to identify what the minimum is.

Michael – Tradeoffs b/t yield and residue left/removed for feed.

Louis – UNFCCC negotiations. Need synthesis book on technical potential of C seq.

Erick – WB has been looking at funding C seq. Not worth it to farmers – addition is so small. Anything to do with MRV is very complicated. Protection of pool should be priority, additions would be icing on the cake. Cannot afford to be losing C as we are trying to seq. it.

Louis – agree. Soil C is very delicate – can be reversed.

Lini - Burning research questions for soil conservation:

- Avoided degradation
- Avoided emissions
- Water capture

Mario - Perhaps frame the question about biomass

Marja-Liisa – realistic picture of net emissions - no till is attractive to farmers b/c they can save energy costs.

Ivan – In conservation agriculture, emissions are neutral (in one research project). This is very important.

Lydia – struck that C value is small. However, sense is that there will be different systems, not payments per farmer.

Henry – In smallholder farming systems, transformation to no till systems is encountering barriers. We should look at what kind of institutional arrangements can be made to address this.

Rachid – question of mechanization.

Michael – This type of technology is reduced inputs and increased productivity. Document and give to decision makers.

Edward Allison presentation. Herbivorous species are the key to low-C aquaculture.

Christine – What do you think about a research approach that incorporates wild fisheries management approaches to compare.

Eddie – looking at that as well. Fishing fleet emissions can be reduced by simple practices. Also investigating blue carbon sources – potential for effective management for protected areas. Separate schemes for food production and wild area management.

Mario – Is there data to do a global analysis on protein shifts from meat to fish?

Eddie – Some. Fish to 2030 study.

Henry – What are the potentials for adaptation funding for mangroves reducing potential flooding in coastal zones?

Eddie – COP15 tried to get coastal systems recognized in adaptation discussions. Being pursued now by several groups. Viable food production systems that buffer rising ocean levels, etc.

Lydia – Relative productivity?

Eddie – hugely variable.

Bruce – Strategic thing for CCAFS is understanding where the issues are going be in the diversity of options available to us. We need tools to compare so we know where to invest.

Lini – also interactions!

Jim – How to prioritize? What's the single metric to look across these options? Like the idea of standard approach for LCA to measure in terms of C emitted/unit of output. E.g. equivalents.

Michael – We need to be very precise when comparing apples and oranges.

Erick – Trophic issue. If feed is huge component, then provided you've got the right feed resource, you could reduce the GWP. Landscape scale

Marja-Liisa – FAO hopes to improve database on mitigation for LCA.

Jim Gockowski presentation. Forests as fertilizer.

Rodel – LCA for cocoa?

Jim – not yet.

Erick – Has anyone mapped out the age classes of cocoa in area you are working in?

Jim – yes.

Christine – How does this relate to climate smart agriculture?

Marja-Liisa – we need to make a connection b/t increased production and reduced emissions. Looking at landscape management of interactions between land uses and optimizing C content and producing food – we have to have some control measures. Can't trust markets to strike optimum balance.

Wednesday – Adaptation Session II

Mirjam Pulleman (Wageningen Univ): Biodiversity and climate resilience

- When talking about working at the landscape scale, how to define “landscape”?
 - Sites must be: Sufficient size to explore interactions, but manageable
- Diagram: Why are agroforests high ecosystem services but low (agric) productivity?
 - BUT can be more productive if there are also goods that come from the trees
- How to quantify biodiversity?
 - Land and soil biodiversity – e.g., number of species/families of plants...
Though soil biodiv is difficult to determine and labor-intensive to measure using trend-sects(?)
- Ecological intensification = intensif of agric based on internal resources (defn from European committee?) → but contested defn

Laura Snook (Bioversity International): The role of agricultural biodiversity at the genetic level in adapting to climate change

- Example on last slide re: US experiment on diversified/rotating agric reducing fertilizer inputs → means less fossil fuel inputs, but DOES require more labor (why it won't work in the US, but maybe helpful for labor-available areas in dvlping world)
- “matching seeds to needs”
 - how to match needs when there are multiple futures (diff models, diff time scales) – also predictions must be downscaled to an agriculturally significant level
 - need many more analogue sites to refine this

Free Discussion

Thematic/Theoretical Issues

- Biological *and economic* diversification – are there tradeoffs?
- Is diversification better than intensification? (...as a farmer, given these 2 options)
 - *Alternative models of intensification*: Is our historical model of intensification (simplification, homogenization) the ONLY model of intensification? In the past, intensification was based on the idea that we could CREATE the environment we wanted to maximize yield. Under uncertainties of CC, can we accept that we don't know what that ideal environment would be--and think about intensification differently?
 - Agroforestry systems = type of intensif? (when they end up as more productive) ... synergies btwn biodiversity, adaptation, and mitigation
 - Historically, 2 models of intensification:
 - Labor-scarce (US) → save labor, use capital (e.g., built machines, etc.)
 - Labor-intense (Asia) → save capital, use labor
 - SO... looking fwd: what's cheap? Information! CCAFS needs to take advtg of information revolution
 - Farm sizes will prob get larger (esp as incomes increase and ppl move out of agric sector) – so we need to think about how to adapt these kinds of farm systems
- Need to engage with climate scientists more?

- Need for “brokers of knowledge” to translate complex projections/technologies/etc. to the end-users
 - Part of this is learning the NEEDS of end-users
 - “Inter-disciplinarity,” not just multidisciplinary

Modeling and Making Robust Projections

- Downscaling properly – keeping projections robust but making the info relevant for decision-makers (Is it more of an art than a science?)... UK project got heat from climate modelers but policy-makers loved it
 - Eike Luedeling: planning to do something similar for Africa
 - Rather than making projections (with very high uncertainties), could we just extrapolate from historical patterns?
 - Empirical methods are difficult
 - Advantages of projections: can tell us the RANGE of possibilities... so we can try to ensure we have a RANGE of responses/crops available (this is the way to use the models sensibly)
- Need to include more variables in projections or take advantage of inter-annual variability, etc. – must refine methods
- Reliability of climate data in developing countries, esp. re: rainfall
 - Ongoing research via CCAFS grant – Andean region (Roberto)
 - Similar Central Asia research (Vladimir)
 - This is not just a scientific problem but a political one – need custodians of such data to open up their archives

Analogue Approach

- Darwinian approach to let system learn itself? Just introduce things and see whether the system can evolve properly...
 - BUT those that “win” today won’t necessarily (and will probably not) work in the future, given GEC → why climate analogues are a great idea!
- Analogues: how can we think beyond biophysical variables to also include human/social characteristics?
 - How to separate CC as a driver from other drivers affecting landscapes? – difficult/impossible, so maybe a need to think about analogues on a LANDSCAPE scale

Concluding Key Messages/Ideas (for plenary)

- Comparing alternative approaches to reconstructing historic climate
- Intensification vs. diversification (from biological and socio-economic points of view)
- Thinking about (potential) climate change winners – keeping a balanced perspective
- Assessing current on-the-ground adaptability
- Robust climate change projections at a meaningful agricultural/decision-making scale (tradeoff: specificity vs. uncertainty)
 - Space for involving climate scientists here!
- Systems-level adaptability and response to climate change (integrative: bio, social, economic, etc)
- Energy-agricultural (esp. water) nexus
- Experimental methodology for evaluating impact/success at system level of specific

- adaptations/policies/interventions
 - “Convergence of Sciences” – economists seeing how coffee price increases affect systems, also studying payments for ecosystem services
- Genetic AND species diversification as win-win synergy between mitigation and adaptation (providing ecosystem services and improving resilience)

Thursday - Mitigation Session I

Henry Neufeldt presentation.

Alex – bundles are more complex.

Henry – yes.

Mario Herrero presentation. 50% of world grains associated with meat production. Biggest CC impacts are land use change and N₂O. Sig potential to reduce emissions, esp in places where productivity is low. Need to delve into social and economic impacts when considering the GWP. What will people do when you displace them? Sustainable intensification is essential – fewer better fed animals reduce emissions. Understand trade-offs with a “multi-currency” approach for multifunctional sustainability objectives.

Michael Peters – ruminant production is on less productive/marginal lands.

Christine Negra presentation.

Rodel Lasco – role of civil society/NGOs? Remember that forests took 10 years to take off, it will take time for Ag as well.

Gerald Nelson – worry about whether REDD is going to be a big mistake. How do we learn from the mistakes? Ag mitigation may be easier to do and justify than REDD.

Louis Verchot – If CGIAR and CCAFS want to get involved, they need to start showing up. Hope that CCAFS secretary can engage policy makers, who are hungry for this information. Otherwise we won't see Ag go forward, won't be pro-poor, won't be sustainable.

Christine – Also real time, country specific information is very useful to policy makers.

Alex de Pinto presentation. Marginal land has low mitigation potential. Farmers on marginal land have an incentive to replenish the resource; farmers on good land have an incentive to mine the resource.

Louis Verchot – Experience shows farmers have an incentive to leave degraded land, not invest in it.

Alex – yes, but there is an inherent difference in behaviors – how they react to increasing carbon. And yes, skeptical, but something we need to explore.

Lini – Can people draw upon presentations to think about the research priorities?

Michael Peters – So maybe potential for degraded lands is huge, but difficult.

Lou - Possible but expensive

Michael – On complexity of payments – do we need a common certification system, otherwise transaction costs will be too high.

Christine – sense that there is experimentation with building incentives. Idea: successional scheme for CCAFS? Maybe PES is early successional species for shifts in land management practices, and other programs come in when it's about upscaling. Research direction, project, support tools could be a CCAFS research priority – how to know when to use which approaches in which contexts.

Mario – re: degraded land. In Latin America case, it seems to be good. Need to know how to pick our battles – which land?

- Jim – Our question should be what do we do if everything remains at national level and project based interventions are viewed as too costly and difficult. Experience with PES and CRES seems to point in that direction. What is the implication for CCAFS agenda on food security and mitigation. Seems to come back to the argument about intensification and land use change on a global level.
- Mirjam – how to prevent that – payments for degraded lands reduce food security. Lower interest in ag because they receive money and can buy food, or may require labor not for food production.
- Gerald – From tech perspective, most of the things you do for degraded lands is good for food production, not bad, with some short term consequences. Coffee example (5 million ha in Kenya abandoned due to Vietnam). Indirect impacts are much more powerful than direct impacts. We need roads in the country side so they can sell.
- Maisa – need to address at 2 levels. 1) farmers, need an incentive to adopt practices that mitigate. 2) National level, whether country has an interest or obligation to mitigate, it has to decide how to do it.
- Roberto – Pasture leads to increases in C in soil?
- Mario – yes, it was calculated.
- Erick – I think we’re underselling the idea of intensification. Brazil decline in deforestation. Financial sector interventions preventing incentives for deforestation. It’s not clear that REDD will go ahead. Eliminating fire is key – how to get fire-free intensification. Fossil fuel development losing steam. CCAFS may want to commission a study on bio-energy. This is an interesting pathway for intensification. We need to push the envelope. Also, tenure and pastoralism is important – these two extremes. Pushing tenure destroys the system. Pastoralism only requires access. Interesting environmental service provided through ancient agreements in Africa. Indigenous communities – some signing over of forest rights. Interpol looking into REDD as a money laundering scheme. We might want to have someone come talk to us about that.
- Lini – sounds like consensus that payments will be difficult, if not impossible, to the farmer. Payments to nations may expand growth without a transformation that leads to low-c development.
- Erick – many examples of low-c development.
- Ivan - Conservation agriculture for intensification. Seq is in question, but certainly lower fossil fuel use.
- Christine – CCAFS research agenda – don’t pursue the “right” answer. Create a typology of intensification. Tool to know when to use what.
- Michael – agree conservation ag may be one avenue. There will be some tradeoffs between economy and environment. E.g. balance b/t soil fertility and income.

Thursday – Adaptation Session I

Eddie Allison (WorldFish): The costs of adaptation in the aquaculture sector in Vietnam

- Microfinance not one of the considered adaptation strategies
- Employment implications: 200,000 displaced fish farmers in the next decade
- Clarification: dykes = walls surrounding ponds (so each farmer has to bear the costs of raising those dykes to adapt to CC, unless the state invests in building a larger wall around all the ponds)
- Methodology: one of the limitations of the study = had to rely on expert opinions

- (Vietnamese climate modelers + farmers) to try to figure out what impacts of CC have been in the last decade (without conflating other variables, e.g. market failures/access issues)
- Also difficult bc the actual market has changed a lot in the last decade
 - Clarification: ponds are individually-owned and compete with one another. But yes, there exist opportunities for community pooling of risk...
 - This was not
 - Another limitation: projection of future feed prices bc this is such a huge cost that everyone's looking for alternatives. Assuming a lower-cost option is found, this will extend the viability of the sector.

Andrew Mude (ILRI): Building climate-resilient livelihoods through index-based insurance

- You are paid according to the readings of regional division where you are based, even if your livestock roam beyond the borders of those regions
- Viability of index-based livestock insurance (IBLI) under CC?
 - “this is not a good CC product, it's a good climate extremes product”
 - if CC trends manifest themselves (quickly), companies may either lose interest or prices will need to go up
 - for pilot program, companies wanted an “ambiguity premium” bc they claimed that CC trends were already apparent and proven
- In this cycle, no payouts bc good rains... So will need to continue studying. E.g., question of whether fewer farmers will buy into the product for the next year?
 - Importance of education and extension to ensure that farmers really understand what the product is
- Further research and policy questions:
 - Group-based insurance marketing
 - Linked credit and insurance
 - Risk layering
 - Conditional insurance transfers
 - IBLI impact on livestock holdings (but also Q of whether having more livestock is better or worse? On one hand, it is a form of asset savings...)
- Currently, one insurer...
 - But problem is that market is so thin, can dictate the price (same issue as with crop insurance)
- Data limitations (monthly back to 2000, gets thinner after that?)
 - E.g., program expanding to Southern Ethiopia
 - One method is HH surveys to figure out historical responses
- What about cattle who die from reasons not (directly) linked to the index?
 - In both cases (ASAL Kenya, southern Ethiopia), very high percentage of livestock deaths is bc of drought. If you look at # of deaths in times without drought, few livestock deaths.
 - Insurance companies cannot manipulate the index, so they will pay given the “strike” indicated in the contract (in this case, strike = 15%, i.e. if the index predicts that >15% of livestock will die)
- Insurance prices? Typical livestock holdings worth about \$2000 and livestock = ~80% total wealth. Cost is \$23. So sell one cow to insure ten (?? CHECK

NUMBERS!)

End Discussion

- Rather than discussing uncertainty in terms of a %, maybe we can think about it in terms of a temporal range. As in: we know this will happen, but just not sure when (e.g., sometime between 2020s and 2040s).
- How does one take into account for autonomous adaptation in our models? And how to monitor it?
 - Vs. “planned adaptation” – much larger scale
 - Is this the same thing as asking: What do people do that they won’t do anyway?
- How to determine what the optimal actions today are, given projected changes for 10-15 years from now? (in other words, maybe the status quo would still be optimal from the farmer’s standpoint?)
- Researchable topics for CCAFS?
 - Index-based insurance: scaling up, economists working with agronomists, taking CC impacts into account, pricing, cost-effectiveness vs. traditional disaster relief, expanding to other types of systems (beyond pastoralists), lowering basis risk
 - What sort of index-based products make sense in what contexts? And which currently extant applications don’t make sense?
 - Risk layering – thinking about the whole portfolio of options
 - How insurers can reward climate-proofing behavior
 - Any other way to incentivize/reward mitigation behavior too?
 - Linking microfinance providers or payments for ecosystem services to insurance? (bringing together instruments from the development world with those from the CC/environment world) – might yield synergies?
 - Maybe requires other managers other than commercial ones?
 - Green bond idea – rewarding states for good behavior?
 - Quantifying impacts of CC and quantifying value/costs of adaptation strategies
 - Issues of uncertainty: Biggest issue with adaptation is that you’re making decisions for an uncertain future
 - Uncertainty – what it means to farmers
 - Are they adapting to historical conditions? Present conditions? (If so, future uncertainty doesn’t matter to them because they’re not even thinking about that?)
 - What do CC models mean to farmers? Does it affect their behaviors?
 - Peter Cooper hypothesis
 - What other sources of uncertainty are there? What other drivers of decision-making exist?

Thursday Mitigation Breakout II

Lydia Olander presentation

Henry – put something on the web to compare different results, even with different models.

Ivan – do you have capacity to run the models?

Lydia – just synthesizing information.

Ivan – where to get these models?

Lydia – online.

Ivan – how to calibrate GHG without data?

Lydia – they are fairly confident in the calibration, but level of confidence indicated for the modeler's perspective.

Jim – you're modeling GHG and yields?

Lydia - focus is net GHG, yield available too.

Lini - Applicability of these models to developing countries?

Reiner – Careful with definitions – Tier 1/2/3 in IPCC reports emissions factors. Used here for a different purpose than the IPCC purpose, which was to calculate emissions for entire countries.

Lydia - Focus is on how models are used for projects. We realize it shifts the definitions, but used it because it is a familiar approach.

Henry – did you talk about multiple gases? Pos/neg feedbacks b/t gasses.

Louis Verchot presentation.

Lini - What are the big research questions?

Louis – Large MRV research agenda that gets at other things we're interested in as well. As an int'l scientific community, we can get a lot of bang for buck. Need to turn these into practical tools.

Christine – In terms of gathering data, can you data for use in a way that can be used for both emission factors and process models?

Louis – yes.

James - Process models good for smallholders?

Louis – the larger the area you are estimating for, the more accurate it will be.

Roberto Quiroz presentation.

Lini – For CCAFS benchmark sites – should be using this to look at soil carbon?

Henry – intriguing approach.

Erick – this is quite data intensive. That said, a lot of data is laying around in various centers. How to access this data is the point. Can we improve access at least at the CG centers? Also, digital soil map of the world – access to enormous amounts of analog data. Also, emissions – how are we addressing sinks? Carbon – biomass. Are there sinks for other GHG?

Reiner – Soil is a sink of CH₄, but fluctuations are very small.

Louis – agree. Very small flux. Not a high priority.

Jim – Nitrous oxide – don't persist as long as CO₂ in atmosphere? Therefore, we need to be mainly concerned about CO₂? Is this correct? Also, can you use this technique (spectrum, laser induced breakdown) to identify nutrient depletion?

Roberto – yes, can use N, P, all others as well.

Louis – Nitrous oxide has smaller flux, but in fertilized systems, it is important. Question on P – can you pick up P?

Roberto – yes.

James – you speciation is just quantitative?

Roberto – some qualitative.

Promising research:

Bruce – big picture: synergies b/t mit and adp. We need more stories. Does anyone have stories?

Is it a synthesis product?

Michael – adaptation of water logged area also mitigates.

Reiner – using irrigation water

Conservation agriculture adaptation and mitigation

Michael – would tradeoffs also be useful?

Yes.

Lini – soil C seq as mitigation strategy? How realistic is it?

Erick - World Bank is supporting pilot activity. Another way to look at it – large stock of C already in soil that could be emitted. Is there a way to get to that, despite other variability.

Lydia – need current trend – are we currently losing C from these systems or now?

Louis - C loss associated in tropical wetlands.

Erick – reducing erosion is reasonably good measure.

Ivan – potential for deep rooted crop systems as a way to sequester and adapt to CC

Reiner – standardization of measurement techniques to get consistent datasets.

Are there policy questions?

Louis – there are huge policy questions. How to properly assess current emissions and how to track progress against emissions, big challenges at national and sub-national level.

Jim – way to correlate gains with MRV for land use change. Correlations between productivity gains and avoided deforestation. Monitor productivity as a proxy for land use change.

Drivers of deforestation, increases in land use change. Switch extensive model to intensive model.

Louis – increased productivity may increase deforestation, according to economists, due to increased value of land.

Maisa – how to tap C seq potential in grasslands.

Christine – fire dynamics important?

Michael – C seq potential changes b/t native and planted grasslands.

Lini – CCAFS Output: Synthesis of MRV models appropriate for developing countries.

Lydia – key data gaps, get modelers together.

Reiner – links to policy – to what extent can we contribute to IPCC process?

Henry – synthesis of model approaches – not about finding best or most appropriate, but using an ensemble to find out how they vary. An assessment of strengths and weaknesses.

Lydia – don't we need recommendations for countries?

Jim – how useful are these models for perennial crops?

Lydia – they have perennials, but don't know how well they model them.

Louis – many of these models were developed for temperate systems, and are being applied in the tropics.

Thursday – Adaptation Session II

Mario Herrero (ILRI): Household vulnerability assessment for rural livelihoods in East Africa

Andy Challinor (University of Leeds): Using climate models for assessing adaptation options

- Better to use specific data on specific crop varieties to make the CC projections? Or to aggregate them into one type of crop?

- Two camps of beliefs:
 - There's so much uncertainty anyway that it doesn't make sense to go that in detail
 - Yes, we need to reflect real life and ensure that our projections mean something and are applicable
- What does uncertainty mean? Range of possibilities

End Discussion

- We're doing lots of complex modeling but are we getting any closer to any simple diagnostics?
- Whom are these models for? Primarily scientists, maybe policy-makers? But how do you translate these models and communicate them to farmers?
 - Why do farmers need to be the audience? Much of this info doesn't need to filter down to them. This is kind of a process to inform ourselves first...
- Need to move beyond general discussion for need for indicators. We aren't starting from scratch.
- Which indicators should we focus on? There are a range of options.
- Are there any geotechnologies available to affect atmospheric levels? (e.g., suck out CO₂ from the atmosphere, inject certain particles in the air) And have we ever tried modeling these possibilities in the models?
 - These technologies are a long way off.
- Are there programs for breeding cold-tolerant crops?
 - Very doubtful that this is necessary.
- Modeling seems generally very probabilistic and deterministic. Are there analyses of how existing systems work?
 - Need for Bayesian approaches?
 - We are starting to use such methods and they're becoming more popular.... So they exist.
 - Peter Laderach: has used Bayesian crop niche models
 - How much do we understand about the capacity for adaptive change in humans and societies? Learning about how we've gotten to where we are. (Think about how quickly change happens to reflect population change, market access, etc.)
 - Currently models work from biophysical models, whose data then feeds into socioeconomic models and exogenous and endogenous responses
 - Degree to which international trade can compensate (IFPRI report on website—shows “envelope of possibilities” for 2050 in terms of food security)
 - But assumes free(r) trade market!
 - Recent food crises: higher (de facto) trade barriers, land grabs/acquisition, etc. → How do we prevent nationalistic/protectionist policies that go against common good/ global food security?
- Models looking at crops, aggregate scale, markets. Goals are alleviating poverty and do think about HH level. Gap in economic analysis: what about work on looking at ex-ante modeling of interventions at HH level?

- We already do that, but not taking into account CC. We have some models set up, but we haven't tried to use them to look at adaptation interventions. Could try case studies in CCAFS regions.

Conclusion – Key Points/Ideas to Present at Plenary

- Reflecting on different kinds of uncertainties: metric, temporal, structural (haven't included all the relevant factors), and translational (do these results mean something to a set group)
- Increase HH-level modeling of ex-ante adaptation interventions (test new options, link regional efforts, run various scenarios)
- Address cross-sector costs and tradeoffs in adaptation strategies
- Indicator-based integrative vulnerability assessments – cross-sector, from food systems perspective
- Standardize indicators and data set for vulnerability analysis across CCAFS
- Impact delivery / communications
 - How to explain uncertainties to end-users/decision-makers and incorporate those uncertainties when making decisions
 - How to make climate model information more user-friendly to different audiences
 - Is this the CGIAR's responsibility? If not, whose is it?
 - Maybe we should just say "no" to communicating directly to farmers. Is this our place?
 - Who can/should be our partners in this effort?
 - Understanding WHO the users/audiences are, and what they want/require – trying to make the CG more demand-led
 - Linking to journalists, social media
- Actionable products/tools that aggregate complex climate information (e.g., insurance premiums, green bonds)
- Decision support tools (to contribute to impact/uptake pathway)
- Strengthening social science research on behavioral change and how to impact policy

Annex 5: CCAFS Planning Meeting

Question: What are the two ideas that came up during the past two days that you are most excited about and would like to work on in the future?

Participants organized their answers in the following categories:

Intensification

Vladimir, Mario, Lieven, Alex, Reiner, Iván, Lini, Henry, Jonathan

- Agricultural intensification versus mitigation and macro effects. Global model of land use change (Jim)
- Intensification and landscape scale effects on mitigation (Lini)
- Sustainable intensification as an adaptation / mitigation option in C-L systems. Partenrs: All CG centers / ESSP (Mario)
- Cross cutting theme for mitigation: Enhancing resource use efficiency, including MRV (Reiner)
- Using seasonal forecasting / climate information as drivers for improved crop and production (yield gap) technology adoption (Peter C.)

Diversification – intensification

Laura Snook, Mario H., Eddie, Rachid, Jonathan, Peter, Henry, Jim H.

- Intensification versus diversification and alternate models (biological versus economic) for diversification
- Diversification / Intensification: Escaping poverty traps and remaining climate change adaptive. Theme 4 with theme 1 and 2 and macropolicies (Eddie).
- Diversification as a CC adaptation strategy (genetic, crop, farming system) incl. tress, crops, livestock, fish) Bioersivity + ICRAF + Worldfish + ILRI + CCAFS; start with critical lit review (Laura Snook)
- Critical review of development pathways based on diversification and intensification, leading to hypotheses and research strategy for changing climate (Jim Hanson)

Breeding

Rachid, Peter, Andy, Ramni Jamnordess (via Henry), Iván

- Change in breeding objective for climate change adaptation (i.e beans) (Details with Steeve Beebe at CIAT)
- Phenotype and model adaptation tolerance traits of mini-core (or other collections) co-financed CRP3 (Peter C.)
- Measure genetic gains under heat stress conditions (Iván)

Impact of CBD / other policy (and other?) impediments on access to and exchange of adapted germplasm across national boundaries. Bioersivity / GRP (centre Genebanks – Laura Snooks)

Adaptation and Mitigation synergies

Vladimir, Michael Peters, Mario H, Alex DP, Iván OM, Rachid, Reiner W., Lini, Henry

- A vision for Carbon-neutral landscapes for food security: integrating adaptation and mitigation at large scale (all CGIAR and ESSP) Eddie
- What are the common governance structures and institution that help people to adapt and mitigate
- Adaptation and mitigation in vulnerable areas. B. Humidicola, BNI, Water logging -> Link 3.7. Degradated areas LAC (need for complementary funds) (Michael Peters)
- 20 stories of adaptation and mitigation synergies (Lini)
- Conservation Agriculture (zero tillage for adaptation and mitigation of CC (Rachid with ICARDA, CIMMYT, etc)
- Marginal land: Mitigation potential and economic incentives (Michael, Alex)

Adaptation

Iván OM, Henry, James, Eddie, Rachid, Peter

- Analysis long term village level data (Indi, West Africa) for adaptation strategies, climate policy growth (Peter C.)
- Cross cutting theme for adaptation: Enhancing resilience to climate extremes (Reiner)
- Adpation of farming systems (Details with Andy Jarvis)
- Spending the adaptation fund effectively to support food security – a CCAFS statement / policy guidance note. Eddie
- Case studies testing the adaptation framework of Simone Cook at al.
- Transitions of agricultural systems and livelihoods with climate change using analogues (Henry)

Integrated Analysis

Mario H, Lieven C, Eddie, Henry, Andy, Vladimir, Lini, Jonathan

- Multicurrency approach to trade-offs of different incentive schemes for mitigation (Lini)
- Integrated indications / information products for food security / Adaptation (Andy)
- Social and economic impacts of mitigation / link mitigation to livelihoods (Lini)
- Global food systems vulnerability map: research output plus communications tool (Eddie) ESSP + IFPRI + CCAFS
- Vulnerability mapping of different land use practices (Henry)
- Benefit sharing in rewards for ES schemes (Henry)
- Assessing trade-offs and synergies of adaptation and mitigation options (Mario)
- System trade-offs between food security, income, C emissions, avoided deforestation, biodiversity. Alex, IFPRI/ICRAF/ASB/CIAT/P. Laderach and Jim-IITA

MIT Potential

Eddie, Rachid, Lini, Henry, Iván OM

- Comparison of mitigation potential across sectors / practices (Lini)
- What are the emission factors for different practice packages

- Analysis / synthesis on potential for C sequestration in the rangelands (white paper)
Rachid, ICARDA, ILRI

(Ex-ante) evaluation of adaptation

Liven C., Mario H., Andy, Jim H., Jonathan

- Getting farmer driven adaptation into models (Andy)
- Ex ante assessment of CC adaptation strategies (with bio-economic model at household level) Lieven
- Process (workshop / consultation) to bring resilience and household modeling community together to develop a framework for assessing adaptation impacts on livelihood resilience (Jim Hansen)
- What drives farmer decisions? How can climate adaptation oriented actions contribute to make them better informed? (J. Hellin)

Important others

- Energy-water nexus (Vladimir)
- IWMI-CIP CRP 5: reconstruct rainfall and (possibly) runoff time series from RS NDVI (veg. index) (Vladimir)
- Exploiting ground water (Andy)
- Development of novel techniques for (field) measurement of soil carbon and stability (Lieven / Roberto Q.)
- Impact analysis of policies within CGIAR centers that have successfully promoted linking knowledge with action leading to a synthesis paper report (Moushwmi)