VITAL SIGNS

Vital Signs Tradeoffs Workshop

Somerville College, University of Oxford
Oxford, UK
February 5-7, 2014

The Vital Signs tradeoffs workshop was organized to bring together key researchers developing tradeoff tools and analysis to guide the Vital Signs data analysis and communication system. The VS threads of sustainable agricultural intensification were used as a focus for discussing tradeoffs and synergies (Appendix 1). The specific objectives were to:

1. Present and review current approaches to evaluating trade-offs between different elements of human wellbeing, specifically within the conceptual frame of 'sustainable agricultural intensification' at farm, landscape, regional, and global scales, and from economic, agronomic, conservation, development, ecological and social perspectives;

2. Explore the strengths and weaknesses in current models and approaches and suggest ways to combine formerly separate techniques. For instance, how can approaches used in systematic conservation planning, economic frontier curve analysis, inclusive wealth accounting, biogeography, biogeochemistry and agronomy assist us to reach robust decisions?

3. Prepare a position paper on an integrated approach for assessing Sustainable Agricultural Intensification.

The agenda and list of participants are attached at the end of this report as Appendices 2 and 3, respectively.

A brief description of the different sessions, discussions and supporting documents are given below. All presentations made during the workshop are in the Dropbox Folder 'Vital Signs Tradeoffs Workshop' (if you need access to the folder please contact Sara Barbour at sbarbour@conservation.org).

Discussion of Vital Signs and Sustainable Agricultural Intensification
(Andelman, Palm, Scholes)

- History of Vital Signs, beginning with a field workshop in Tanzania in 2010, pilot project in Tanzania in 2010, workshop on indicators at the Gates Foundation in 2011, and Vital Signs project launched in Feb 2012.

- Three-year grant with focus on developing a system for data collection (co-location of spatio-temporal data sets; use of existing data and systems as much as possible; storage, analysis and use of information by decision makers.

- Analysis threads, with data/observations; analyses for intermediate indicators, and final integrated indices.

- Three countries as focus for first three years.

- Sustainable agricultural intensification thread (Appendix 4) as a focal discussion point, because it incorporates many of the indicators and sub-indicators of the various VS threads that lead to analysis of tradeoffs and synergies.

Discussion and Questions

1. The term "sustainable agricultural intensification" has been co-opted and often assumed to mean things like GM crops or large-scale corporate based agriculture. Is it worth it to try and revive the term as a means for assessing multiple pathways for agricultural intensification and the balance among production, livelihoods and the environment? The point was stressed that there can be multiple routes to intensification depending on many circumstances and opportunities; there is a need to be able to assess the multiple outcomes of such intensification. VS is not trying to have one index for sustainable agricultural intensification – it is not a box in the VS thread – but a space to assess the tradeoffs and synergies.

2. Is VS prescriptive at bottom of threads but not at high levels of analysis? Decision indices are not prescriptive, but the data collected for that index is fixed.

3. Do we have a sense of what are acceptable tradeoffs, the form of the tradeoff curves and how decisions should/would be made with this information? e should not look for optimization, but perhaps look to see if something was not optimal instead.

4. Who are the stakeholders and decision makers, and what information do they need? VS is working a regional scales with ministerial planners and development agencies.

5. Will Vital Signs conduct scenarios/forecasting rather than prognostics? Vital Signs is a monitoring system, so in essence that means prognostic rather than scenarios/forecasting. VS could provide the data for others to conduct scenarios/forecasting. In the end there must be a simple story based on

credible data (from the past, near real time). This topic is covered in more detail in a later section.

6. Models can be used for building the plausible narratives, but they will not be perfect and not useful for all scales. But several approaches (models) can be used to triangulate and check where the different models agree/or disagree and for what reasons. This leads to improving the models.

7. Should VS provide tools/models for analysis, or just provide information for tools and let others provide the tools? Models are absolutely necessary for monitoring. There is no option not to use models. Perhaps VS can start by providing better data that models require and later focus on providing improved tools/models. Models are also valuable because they make data needs very explicit. But you have to be confident that you're looking at the right models. What are some of the key uncertainties and gaps in these models? How can we make these models more useful? Perhaps it's not about getting numbers more right, but more useful for decision makers?

8. What do decision makers need to visualize? The data being put into models and then the model outputs.

9. Need to include and look for synergy space, not just tradeoffs.

10. Will Vital Signs provide location data (and still respect confidentiality issues)?

11. Does the agricultural intensification thread include livestock intensification? (a small group discussed this later, resulting in a revised livestock thread).

Summary

Who are we aiming/developing this system for? What is the desirability of using sustainable intensification term? What is the balance of prognostic versus diagnostic capability, and what is the relationship? There should be multiple ways of doing this so that people can pick their favorite approach and also to build confidence: triangulation. The importance of understanding interactions, thresholds: nature of things and relationships. Gap analysis (of tools). Are we including enough resilience type questions? This may not be so much about analytical tools, but more about visualization tools – making them useful.

Presentations on Tradeoff Models

Presentations were made by:

John Antle – Oregon State University
Santiago Dogliotti - Universidad de la República, Uruguay

Petr Havlik- International Institute for Applied Systems Analysis (IIASA)
Keith Kline - Oak Ridge National Laboratory (ORNL)
Philip Thornton –Climate Change, Agriculture and Food Security (ILRI)
Pablo Tittonell –Wageningen University
Peter Thorne – ILRI – Africa Rising

All presentations are posted in the Dropbox. Two people were unable to attend (Patty Balvanera, Universidad Nacional Autónoma de México, and Jennie Barron, Stockholm Environment Institute; their presentations are also posted in the Dropbox.

Discussion to Determine Next Steps

- Classify the modeling approaches: scale, algorithm, the question each model is trying to answer, map these out and determine if/links there are between models.

- How to link indicators with Sustainable Development Goals (SDGs) so countries have an interest because it links to international contributions.

- How do the indicators and models link with the BMGF environmental sustainability planner for assessing proposals? Problem is still that data are missing.

- Tradeoffs tend to be between environment and production so the analysis does really look at adoptability, though we could explore the options that are financial viable as the first step.

- What are the questions we are trying to ask? How to use experience for other projects using models that were developed to answer different questions.

- There needs to be consensus on what models are appropriate. Worst-case scenario would be that someone comes with a different model that shows the opposite and there is no confidence in the models.

- Data availability, particularly for Africa, is a big factor in being able to assess tradeoffs. This was also a conclusion of the Millennium Ecosystem Assessment – data not available to understand the multiple consequences of loss of ecosystem services, or to see to what degree those services have been lost. VS partner countries have also expressed need for more data for decision making.

Summary

Using agricultural intensification as the focus of working groups, the tasks were to:

1. Describe the tradeoff tools that are available and organize them in a way to know what they're good for and what they require; and data needs;

2. Agree on the components needed to assess sustainable intensification - [timescales of defining sustainability; a system may be sustainable now but not under a different climate regime in 2050; benefit distribution]. How do we go beyond pair-wise comparison in a multi-dimensional system (multi-dimensional sausage!).

Two working groups focused on these two points over the next day and a half.

Working Group Reports

1. Sustainable Agricultural Intensification: The discussion resulted in separating the thread into an Agriculture Intensification thread and another one that brings together the high level indicators that come from the various threads that are needed for analysis of tradeoffs and synergies. These modifications are shown in Appendix 4.

There was additional discussion on how to integrate livestock intensification (cut and carry, feedlots) into the agricultural intensification, rangeland degradation, and water quality threads.

2. Model comparisons: A table was developed indicating the spatial scale and indicators captured by current models. There is still need to include models that incorporate biodiversity and more ecosystems services. It was noted that there is also a lack of sufficient coverage of human wellbeing from current models, other than inclusion of income/poverty and to some extent food security (but based solely on crop production converted to calories).

What is still missing is how to do the actual tradeoff analysis – the models provide the different indicator – not the final analysis. This point led to a plenary discussion on visualization of tradeoff analysis for decision making and eliciting behavioral change.

A draft outline for a manuscript based on this table and discussion is presented as Appendix 5.

Discussions

A few other discussions topics were covered and details given below.

1. From Data to Decisions

Two main topics recurred during the discussions relating to data for decision making. One was about the decision makers and how they make decisions, and the other related to the types of visualization tools that are most appropriate for effective change. It was agreed that the issue of behavioral change of farmer/policy makers is beyond this workshop, and we would need additional expertise to do that effectively. Nevertheless, it is a critical component that needs to be addressed starting with a Theory of Change Pathway.

Approaches for tools for better informed trade-off decisions based on the different type of stakeholders and decisions makers was summarized as follows and illustrated in Appendix 6:

- Problem statement: tradeoff decisions are ubiquitous and consequential, but often arbitrary, poorly-justified and non-transparent
  - Who should make such decisions, by what process and using what information? The separation of the stakeholder-led and technical parts of the decision

- The methods available for making single actor or multi-actor trade-off decisions: informal and formal techniques
  - Well-justified decisions by experts or authorised persons
  - Participatory tools for engaging non-technical stakeholders
  - Immersive models, games
  - Multicriterion, decision-making tools

- Analytical approaches that can inform the decision process:
  - Scenarios and simulations as info sources
  - Reduction to a single-factor problem
  - Risk analysis, pareto analysis, typologies and threshold analyses as approaches to 2 or more factor problems

- Indicators and visualisation are used as communication approaches

2. Data Issues

It is important to better define what will be the use of VS data. There are three potential uses of the VS type of data: 1) Current conditions and monitoring

trajectories of change; 2) Ex ante: taking baseline and projecting scenarios; and 3) Ex post: what was the impact of certain interventions.

Essentially VS will be collecting baseline data that could be used to establish relationships among and identify key variables and their variance in the population. The problem is that this approach does not necessarily let us know who are the adopters or non-adopters (counterfactuals) – which is important for ex post analysis and understanding the nature of the variance and the relationship among the variables.

There will be some attempt to survey and measure landscapes that have or are more likely to experience agricultural intensification – but there are financial limits to the number of landscapes that can be monitored. Performing a cost effectiveness analysis of data collection to allow for a reduction of data needs would be important. Comparing the survey tools, methods and cost effectiveness with CCAFS would be valuable for this exercise.

VS should also consider the following points on data. How do modelers approach the data needs? How 'good' does the data have to be to inform policy (the ultimate objective of VS)? What are new tools and ideas for data collection? We must also be aware that a 'good' guess in a complex system may not, in fact, be good.

3. Choice of Crop Models for Vital Signs

The current agricultural intensification thread has a box to link the yields outputs from regional crop modeling efforts such as AgMIPS, Harvest Choice and others. Several participants at the tradeoffs workshop are involved in these efforts. They said that a dropdown list of yields for the number of soil, climate and management types we would find would be extremely tedious to develop using these types of crop models.

They also suggest that the type of data needed to parameterize these models is extensive and likely outside the scope of Vital Signs. The third point was that the level of needed for VS in terms of 'estimating' baseline yields and yield gaps could be achieved by simpler models such as EPIC. The VS team will look into EPIC as the model that could be linked to VS.

4. Linking Data, Models, and Indicators for Tradeoff Analysis

Most modeling of economic, environmental and social outcomes uses "loosely coupled" models, i.e., outputs from one disciplinary model are passed to another. There are some more "closely coupled" models that attempt to integrate several components together, which results in large complex models that require large amounts of detailed data. Loose coupling can be a problem that needs to be

addressed if the temporal and spatial aspects of the models being coupled are different.

EPIC is an example of an integrated model at one level (field-level processes such as yields, erosion, etc.) but is then loosely linked to others (GLOBio) at another level. Scenario SPESS is loosely coupled system nor running in parallel. The easiest is to run the models at the same place with the same input data, the next step is for outputs to become inputs to for the other models, and the next level of complexity to include feedbacks among the models. The outputs can be visualized in another platform (such as STELLA) where the dynamics associated with changes in different variables can be viewed. This is probably the best type of approach for Vital Signs as the first cut.

5. Discussion on Tradeoff Network

Participants were asked about their interest in further interaction as a tradeoffs working group or network.

Antle
Interest within BMGF to develop Next Generation Decision models. Investments made in the 70/80's led to the current generation of models. With new computational power, we need to catch up. The private sector is racing ahead. The current plan is to prepare background papers followed by a workshop towards that end of the year to develop strategy and plan. The three papers are: state of science; what will be the future approach (web-based, modular, etc); computational tools that should be included especially data visualization. There is an opportunity to collaborate, especially since Gates is supporting multiple similar projects, including Vital Signs. The model comparison paper outlined during the workshop would be useful input to the first of these review papers. Another example is the CLEANED Project, which looks at environmental impacts of livestock and fish intensification in East Africa. A collaborative effort among these groups would be valuable.

Thornton
Comparing CCAFS surveys, data and collection efforts and costs with Vital Signs – too look at reducing data collection efforts and focusing a few key indicators. Working in similar landscapes would be quite useful for this purpose.

Kline
Mentioned the ability or ORNL to run complex models and large data sets and possibilities of collaboration. He also mentioned collaborating in the field with the project Feed the Future in Tanzania based at Sokoine University. The grant is led by Ohio State University and provided funding for graduate students on research related to food security. .

Dogliotti
Though he doesn't work in Africa, he mentioned they have a large network that has used their ApsFarm model (version of ApSim) to model more than 3000 households in five countries. This could be a good example of networking field and farm data use among sites and collaborators.

APPENDIX 1

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Sustainable Agricultural Intensification:
Balancing increased productivity, environment, and livelihoods
Notes to guide discussions

Cheryl Palm, Bob Scholes, Sandy Andelman

Global food production needs to double to meet a growing population and changing diets, but the global cultivated area cannot double. The land that is available for expansion is often in 'hotspots' of biodiversity and carbon storage and is a source of many other ecosystem services. Therefore intensifying agricultural activities to produce more on the existing area of agricultural land is the preferred option. 'Land sparing' by intensification is often proposed to meet both the production and conservation goals, yet concerns remain about the on-site and off-site environmental consequences of such intensification. Intensification is often associated with up-scaling and commercialization of agricultural enterprises, raising concerns that small-scale farmers will be marginalized as landholdings are consolidated. 'Sustainable agricultural intensification' has been framed as combining the goal of increasing agricultural productivity while minimizing negative environmental effects and improving rural livelihoods.

Sustainable agricultural intensification is hotly debated: either because people associate it with conventional high input agricultural practices; or conversely, as eco-agriculture or 'land sharing' in another guise. Sustainable agricultural intensification does not promote a particular set of practices, but instead provides a conceptual framework for guiding discussions on achieving balanced outcomes. Thus, there can be alternative pathways to sustainable agricultural intensification that will vary by location and scale, depending on agro-eocological zone, farming system, cultural preferences, institutions and policies, among other factors. Each of those pathways will have a different set or levels of environment and socioeconomic tradeoffs and/or synergies.

Tradeoffs or synergies can arise at multiple scales: at the level of the field, the farm, the landscape, the region, the nation, among neighboring countries, and globally. They can have contrasting effects at different scales. For instance, the common trade-off on increased production at the farm scale resulting from increased nitrogen fertilizer use causing decreased water quality at the landscape or regional scale and increased GHG emissions on the global scale. Some of these tradeoffs

are immediate and apparent while others take much longer to develop and may not be obvious.

A conceptual framework for sustainable agricultural intensification is a good starting point to focus discussions on the tradeoffs and synergies that may arise with different agricultural intensification practices or programs and help guide decision-making. Yet these rather simple frameworks are underlain by multiple, complex interactions in space and time, many of which are at the forefront of complex system research. Various models have been developed that link agricultural production to different socioeconomic or environmental outcomes. Some are simple empirical models, while others are complex systems models. There are few comprehensive quantitative assessments.

Vital Signs (VS) is a prototype integrated monitoring system that combines measurements of ecosystem services, agricultural inputs and outputs, and human wellbeing. Funded by the Bill & Melinda Gates Foundation, and initially active in southern Tanzania, Ghana and a third African region, it will provide much of the data formerly unavailable for evaluating various development pathways. The VS observations are combined with data from many other sources, through the medium of algorithms and models, to generate a rich set of quantitative indicators that are synthesized into decision-support indices. One of the key 'threads' involves the information underlying decisions relating to sustainable intensification. The perspective that Vital Signs has taken is that such decisions are based on tradeoffs and synergies. The aim of VS is not to impose any particular outcome, but rather to provide the information and tools necessary for those making or affected by the decisions to evaluate the tradeoffs and synergies for themselves.

Our initial review reveals the following broad approaches to evaluating tradeoffs.

- Interaction matrices

- Spidergrams, with the 'arms' comparing the relative proportions of different ecosystem services provided by different land use types

- Qualitative and quantitative methods, looking for thresholds and nonlinearities

- Quantitative models, from simple to complex
    - Linear and non-linear optimization approaches such as benefit-cost analysis
    - Frontier curve analysis

- Participatory approaches using multi-criteria decision making, involving stakeholders, experts or both

However, there are few examples where one or more of these approaches has been applied to understand the trade-offs and synergies among all three themes that are the focus of Vital Signs, i.e., agricultural production, other ecosystem services and dimensions of human well-being. The purpose of this workshop is to better understand the state-of-the art in tradeoff analysis, specifically in the field of sustainable agricultural intensification, and if possible to advance it. More specifically we seek to identify the most promising modeling approaches for both analyzing trade-offs and synergies across these areas and for visualizing the output of these analyses to effectively communicate them to decision makers.

APPENDIX 2

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Tradeoffs Workshop

February 5-7th, 2014
Somerville College, University of Oxford
Woodstock Rd, Oxford OX2 6HD

Agenda

Objectives

1. Present and review current approaches to evaluating trade-offs between different elements of human wellbeing, specifically within the conceptual frame of 'sustainable agricultural intensification' at farm, landscape, regional, and global scales, and from economic, agronomic, conservation, development, ecological and social perspectives;

2. Explore the strengths and weaknesses in current models and approaches and suggest ways to combine formerly separate techniques. For instance how can approaches used in systematic conservation planning, economic frontier curve analysis, inclusive wealth accounting, biogeography, biogeochemistry and agronomy assist us to reach robust decisions?

3. Prepare a position paper on an integrated approach for assessing Sustainable Agricultural Intensification.

Expected Outputs

1. Recommendations to VS regarding the tools appropriate for analyzing tradeoffs between agricultural development and ecosystem services.

2. Recommendations to VS and other interested parties on methods for visualizing and communicating tradeoffs to different stakeholder groups.

3. A draft position paper on an integrated approach for assessing Sustainable Agricultural Intensification.

4. Establish a 'community of practice' network of people interested in tradeoff analysis

Program

DAY 1: Wednesday, February 5th

9:00 - 9:15	**Statement of Meeting Objectives and Introduction of Participants**
9:15 - 9:30	**Overview of Vital Signs (Sandy Andelman)**
9:30 - 10:00	**Presentation of VS Threads (Cheryl Palm)** • Focus on Agricultural Intensification and its linkages with other threads • Tradeoffs and synergies
10:00 - 10:30	**Discussion: 'Sustainable Agricultural Intensification' (Bob Scholes)** • Defining, quantifying and combining the various elements of intensity • Defining and quantifying the outcome metrics • How to find the 'sweet spot 'on a continuum of intensification
10:30 - 10:45	Coffee Break
10:45 - 1:00	**15 Minute Presentations by Participants (sequence to be confirmed)** • Introduce approach or model type and its objectives • How are trade-offs captured, modeled, visualized? • What ecosystem services, biodiversity, human wellbeing, or agricultural production aspects are included in the approach/model? • What scales of analysis are included in the approach/model? • Provide a brief case study using the approach/model. • Potential links with and interest in VS threads.
10:45 - 11:00	John Antle – Oregon State University
11:00 -11:15	Santiago Dogliotti - Universidad de la República, Uruguay
11:15 - 11:30	Petr Havlik- International Institute for Applied Systems Analysis (IIASA)
11:30 - 11:45	Keith Kline - Oak Ridge National Laboratory (ORNL)
11:45 - 12:00	Philip Thornton International Livestock Research Institute

	(ILRI)/ CCAFS
12:00 - 12:15	Pablo Tittonell –Wageningen University
12:15 - 12:30	Patty Balvanera - Universidad Nacional Autónoma de México (Sandy Andelman)
12:30 - 12:45	Jennie Barron - Stockholm Environment Institute
12:45 - 1:00	Peter Thorne – ILRI
13:00 - 14:00	Lunch
14:00 - 16:00	**Discussion of the models, approaches, linkages and issues to address during the workshop and formation of working groups (Bob Scholes and Cheryl Palm)**
16:00 - 16:30 pm	Tea break
16:30 - 18:00 p.m.	**Summary from concurrent meeting on Sustainable Agricultural Intensification** Working groups to develop approaches, linkages, problems to specific issues
18:00 p.m.	Break for the day

DAY 2: Thursday, February 6th

9:00 - 9:30	**10-minute reports from Working Groups** Recommendations, next steps – decisions to reconvene and/or form new groups
9:30 - 11:30	**Working groups (coffee/tea as needed)**
11:30 - 12:00	**Reports from Working Groups** Recommendations with focus on linkages and integration, next steps
12:00 - 12:30	**Outline major conclusions, remaining issues – organize for afternoon sessions**
12:30 - 13:30	Lunch
13:30 - 16:30	**Writing groups on various issues and recommendations (coffee/tea)**
16:30 - 18:00	**Discussion on visualizing and communicating tradeoffs**

19:00	Group Dinner

DAY 3: Friday, February 7th

9:00 - 9:30	**Brief 10 min-reports from writing groups** Issues and clarifications
9:30 – 10:30	**Outline of a paper on an integrated approach**
10:30 – 10:45	Coffee/Tea
10:45 – 13:00	**Discussions of next steps, forming a network for tradeoff analysis**
13:00	Lunch and departures

APPENDIX 3

Participant Name	Email	Institution	Position
Sandy Andelman	sandelman@conservation.org	Conservation International	Chief Scientist, Senior Vice-President
John Antle	John.Antle@oregonstate.edu	Oregon State University	Professor, Department of Applied Economics
Jennie Barron	jennie.barron@sei-international.org	Stockholm Environment Institute/SEI and Stockholm Resilience Centre, Stockholm University	Research Leader in water agriculture ecosystem services
Santiago Dogliotti	sandog@fagro.edu.uy	Universidad de la República, Uruguay and Agencia Nacional de Investigación e Innovación (ANII)	Head of Department of Plant Production; Director of National Agency for Research and Innovation (ANII)
Maggie Gill	M-Gill@dfid.gov.uk	DFID	
Petr Havlik	havlik.petr@gmail.com	International Institute for Applied Systems Analysis (IIASA)	Research Scholar, Ecosystems Services and Management
Keith Kline	klinekl@ornl.gov	Environmental Sciences Division, Oak Ridge National Laboratory (ORNL)	Senior Researcher
Mark Musumba	mmusumba@ei.columbia.edu	Earth Institute, Columbia University	Postdoctoral Research Fellow
Ravic Nijbroek	rnijbroek@conservation.org	Conservation International	Research Scientist
Cheryl Palm	cpalm@ei.columbia.edu	Earth Institute, Columbia University	Senior Research Scientist, Director of the Research Agriculture and Food Security Center
Kate Schneider	Kate.Schneider@gatesfoundation.org	Bill & Melinda Gates Foundation	Associate Program Officer

APPENDIX 4

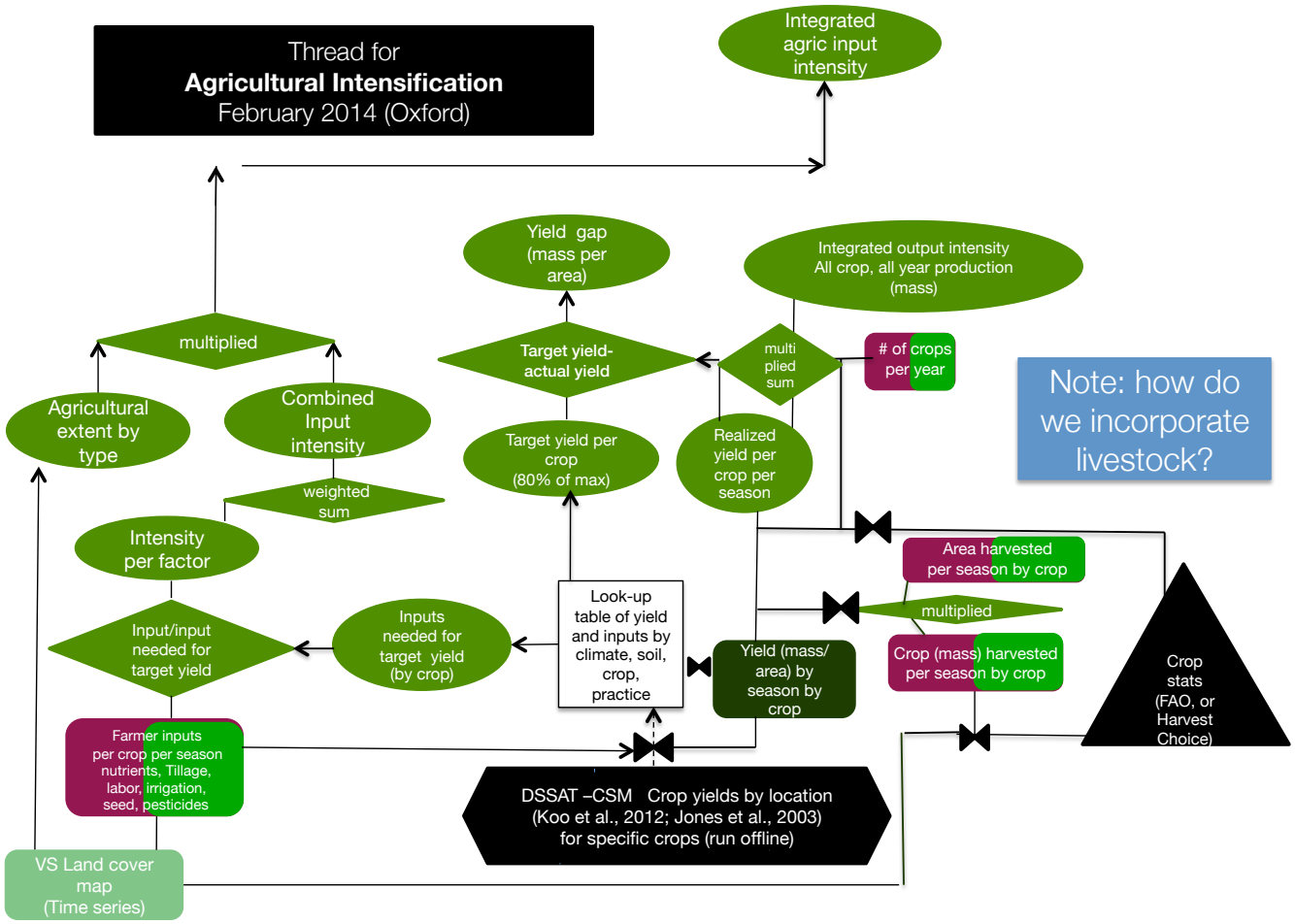
Sustainable Agricultural Intensification

-- is a conceptual framework for guiding discussions on achieving balanced outcomes from agricultural intensification

-- it does not promote a particular set of practices or philosophies.

-- there can be alternative pathways to sustainable agricultural intensification which will vary depending on agro-eocological zone, farming system, cultural preferences, institutions and policies, …

-- each intensification pathway will have a different set or levels of environment and socioeconomic tradeoffs and/or synergies….. the task is to assess these alternatives and make decisions that balance these tradeoffs


Thread for
Agricultural Intensification
February 2014 (Oxford)
Integrated agric input intensity
Yield gap (mass per area)
Integrated output intensity All crop, all year production (mass)
multiplied
Target yield-actual yield
multi plied sum
# of crops per year
Agricultural extent by type
Combined Input intensity
Target yield per crop (80% of max)
Realized yield per crop per season
Note: how do we incorporate livestock?
weighted sum
Intensity per factor
Area harvested per season by crop
multiplied
Look-up table of yield and inputs by climate, soil, crop, practice
Inputs needed for target yield (by crop)
Input/input needed for target yield
Yield (mass/ area) by season by crop
Crop (mass) harvested per season by crop
Crop stats (FAO, or Harvest Choice)
Farmer inputs per crop per season nutrients, Tillage, labor, irrigation, seed, pesticides
DSSAT –CSM Crop yields by location (Koo et al., 2012; Jones et al., 2003) for specific crops (run offline)
VS Land cover map (Time series)
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APPENDIX 5

Outline for Agricultural Intensification – Tradeoffs Model Comparison Paper

Possible Title: Do we have the quantitative tools needed to assess tradeoffs and synergies among agricultural intensification, environment and livelihoods?

Introduction

- Need to review (assess) tools for assessing tradeoffs (and synergies) among agriculture, ecosystem services and human well-being.

- Purpose: What quantitative tools are available to assess sustainable agricultural development? Increasing role of indicators in research-development outcomes. What are appropriate indicators? With some thoughtful treatment of this topic.

- Why models? For projecting out in space and time, allowing 'experimentation through simulations,' are tools used for forward projection? (Issue will be to define Sustainable Agricultural Intensification first)

- Previous reviews – examples of what they cover and provide references to those reviews.

- Review current models (see table at end of this appendix). What can be done with existing models, alone and in combination? What are the strengths and weaknesses of the different models for the purpose of integrated assessment of agricultural intensification? What are the next steps needed to provide the platform for this purpose?

- Examples of case studies that have looked at tradeoff analyses at different scales. Compare to purpose of this review.

- Literature review (of review papers): Summarize strengths and weaknesses (and scales) specifically for purpose. No need for an exhaustive review but representation/illustration of different models.

Which Models or Combinations of Models can inform tradeoffs among all three dimensions? (agriculture, ecosystem services, human wellbeing)

The approach for model descriptions and comparisons will use the table of models that was developed during the workshop. The descriptions will follow the sequence as follows: 1 – Types/style of models and the three scales - small (field farm),

medium (landscape) and large – regional-global. 2 – 3 groups of indicators (agricultural production, ecosystem service, HWB) 3 – types of data as outlined immediately below

Types of Models

Agent-based models
Mathematical Programming (optimization)
IMAGE
Life Cycle Assessments
LUC (Clue)
Rule-based models
Systems dynamic
Partial Equilibrium models/General Equilibrium models
Sustainability evaluation frameworks
Econometric models
Watershed environmental indices
Statistical models
Animal Production models
Cropping System Models (field)

Model Attributes

Scale (time and space)
Environmental services
Dynamic vs. state
Stochastic vs. deterministic
Process based vs. empirical
Assumptions
Spatially explicit
Heterogeneity/diversity

Data Requirements

- Data requirements and limitations of different models/approaches
- Important question: for whom are the tradeoffs (winners/losers in intensification)? For whom is the tradeoff analysis (different stakeholders: scientists, policymakers, etc)?
- What do we want the models to do? Models are not perfect and data limitations but how can they be improved? The intention is for monitoring, not one off assessments (temporal dimensions).
- What are key agriculture/livestock models?
- Use the table of the different models for discussing the strengths and weakness.
- Can models be combined with social science methods to improve results? Is the problem with capturing power relations, gender serious gaps?
- Exhaustive review but any model missed can be added.

The Way Forward

- How far can we get with existing models
  - Where are the gaps
    - HWB as a gap – much of it is not currently modeled or captured now. what could be modeled and what could not be modeled?
    - Gender analysis – currently looking at causal relationships but not yet quantified or modeled. What is the current theory?
    - Institutional and Agent based models now approaching power and gender or the constraints encountered if not the causal relationships

  - Priorities for model improvement, intercomparisions among models to explore why different outcomes. Leading to modification and development of new models

  - What data are needed to improve models

  - How do we move from data to decision making? What are the current tools and processes to get to tradeoff decisions?

Tasks

Model transparency, model description (BLOSM case study) – Keith
Process with stakeholders for model – John and Keith
Landscape scale models (econometric landuse models) – John
Crop/livestock/HH model review – Philip, Pablo, Santiago, Peter
Global model – Petr
Biodiversity (conservation) landscape planning models – Bob
Other ecosystem service models (not yet included in table) – Sandy and Cheryl
From data to decisions – Bob and Philip

Target Journal
Global Environmental Change/Environmental Management

Model Comparison

Scale/Integration Level	small (indiv animal)	field	farm	landscape	region	global
Biodiv				8 7		3
water quality		7, 9		8, 2		
water quantity		4, 7, 9	5,	1	6	3, 11
soil nutrients	12	4, 7, 9	5,	1	6	3, 11
soil erosion		4, 7, 9	5,	8		
soil OM		4, 7, 9	5	1, 2	6	
Land cover				7, 8		3, 10
GHG emissions	12	7, 9		1, 2		3, 10
nutrition		7 (starting)		1	6	3
income		4 (growth margin), 7	5	1, 2, 7, 8	6	10
health				1, 2		
food security					6	11
energy (wood fuel)				8		3
Gender				1		
Assets						10
Yield	12	4, 7, 9	5	1, 2, 7, 8	2, 6	3, 10, 11
Adoption				1, 7	6	3

KEY to models

1	toa-md	7	COMPASS
2	toa-me	8	blosm
3	globiom	9	Epic/DSAT/APSIN
4	field images	10	mode
5	farm images	11	impact
6		12	ruminant

	casp (climate smart ag prioritization)	SWAT RSIM LPJ

APPENDIX 6: From Data to Decisions