Climate-smart soil protection and rehabilitation in Kenya

December 2016, Kisumu, Kenya

An Notenbaert, Birthe Paul, Caroline Mwongera, Celine Birnholz, Chris Mwungu, Deborah Bossio, Evan Girvetz, Ivy Kinyua, Jessica Koge, Job Kihara, John Mukalama, Juliet Braslow, Katherine Snyder, Rolf Sommer, Stanley Karanja, Wendy Okolo
Outline

• Introduction and objectives of the climate-smart soils (CSS) project
• Climate-smartness evaluation
  • Farm Typology
  • Rapid Climate Smartness Assessment (Kalkulator)
  • Evaluation of Land Management Options (ELMO)
  • Attainable impact
• Biophysical assessment
• CSA prioritization framework
  • CSA identification and prioritization workshop
  • Economic assessment, CBA
  • Revised framework
• Recommendations
Objective of the Climate Smart Soils Project

• Assessment of climate smartness of ongoing and potentially suitable alternative agricultural soil conservation practices, including:
  • analysis of farm-level cost-benefit and tradeoffs
  • evaluation of the overall CSA impact and scope
  • adoption and scaling potentials
• Design of a CSA prioritization process and implementation strategy in Western Kenya

“Agriculture has to be part of the solution to climate change.”
Climate smart agriculture

Triple-win goal – three pillars (FAO 2013):

1. Sustainably increasing agricultural productivity and incomes;
2. Adapting and building resilience to climate change;
3. Climate change mitigation: reducing greenhouse gases emissions, where possible.

"To ensure a food-secure future, farming must become climate resilient."
CIAT's approach to evaluate the climate smartness

- **Climate Smartness**
  - Identification of farm major farm types
  - List of major management practices

- **Outcome Indicators**
  - Biophysical assessment
  - Expert assessment of practices
  - Evaluation of Land Management Options (ELMO)
  - Farm household modeling

- **Adoption potential & Impact**
  - Cost-Benefit Analysis
  - Attainable impact
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• Recommendations
Rapid assessment - methodology

Stakeholder workshops → Farming system types → Case study farmer interviews

Soil technology shortlist → Input data

Modelling CSA indicators for baselines and scenarios
**Farming system types**

**Factors:** intensification, production orientation, commercialization, agro-ecological potential and resource endowment

<table>
<thead>
<tr>
<th>Counties</th>
<th>Resource-poor female-headed</th>
<th>Small mixed subsistence</th>
<th>Medium dairy commercial</th>
<th>Medium horticulture commercial</th>
<th>Large commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siaya</td>
<td>NA</td>
<td>70 %</td>
<td>5 %</td>
<td>20 %</td>
<td>5 %</td>
</tr>
<tr>
<td>Kakamega</td>
<td>NA</td>
<td>60 %</td>
<td>10 %</td>
<td>10 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Bungoma</td>
<td>NA</td>
<td>50 %</td>
<td>5 %</td>
<td>10 %</td>
<td>35 %</td>
</tr>
</tbody>
</table>
Shortlisted/tested soil technologies

Stakeholders listed most relevant soil protection and rehabilitation technologies

- Liming and DAP
- Compost only
- Lime and compost
- Conservation Agriculture
- Vegetative strips
Modelling of CSA indicators and trade-offs

Calories produced on farm/hectare
- Cash crops and meat not taken into account
- ‘Potential supply’ only

Soil nitrogen balances farm/hectare
- Simplified, non-holistic indicators

GHG emissions from agriculture per farm/hectare
- Soil C stock changes not included
- IPCC tier 1/2 overestimating for SSA
Calories produced on farm - baselines

- Diversity of production
- Small mixed subsistence, low per farm, but high per ha
- Large commercial, high per farm from milk production, not highest per ha - coffee does contribute to calories
Nitrogen balance - baselines

- Low inputs-low outputs
- Livestock density on the small mixed subsistence farm -> highest balance
- Negative on the medium commercial farms - not alarming; higher export of crop products (and milk).
- Positive on the large commercial farm because of use of inputs in larger quantities.
Greenhouse gas emissions - baselines

- low emissions
- livestock (ruminants) main source
- livestock density on the small mixed subsistence farm → highest GHG intensity
- higher use of inputs on the large farm
Trade-offs: Productivity vs. N balance

![Graph showing the relationship between ∆Productivity (AME days/ha) and ∆N-balance (kg N/ha). The graph includes data points for different treatments such as Lime+NPK, Compost only, Lime + compost, CA, Veg. strip vetiver, and Veg. strip Napier. The legend indicates that □=poor female-headed household, Δ=Small mixed subsistence, ◊=Mixed commercial dairy, □ with patterns=Medium commercial horticulture and ○=Large commercial.]
Trade-offs: Productivity vs. GHG emissions

![Graph showing trade-offs between productivity and GHG emissions](image)

- **Axes:**
  - Y-axis: ΔGHG emissions (t CO2e/ha)
  - X-axis: ΔProductivity (AME days/ha)

- **Legend:**
  - Orange dot: Lime+NPK
  - Light grey: Compost only
  - Yellow dot: Lime + compost
  - Dark blue triangle: CA
  - Green diamond: Veg. strip vetiver
  - Purple square: Veg. strip Napier

- **Annotations:**
  - □ = poor female-headed household
  - △ = Small mixed subsistence
  - ◊ = Mixed commercial dairy
  - □ with patterns = Medium commercial horticulture
  - ○ = Large commercial
Evaluating Land Management Options (ELMO)

Participatory tool for assessing farmers’ land management (LM) decisions, preferences & trade-offs

1. Identify techniques & attributes to be discussed
2. Record respondent characteristics
3. Define LM techniques & baseline
4. Rank & Score LM costs & input requirements
5. Rank & Score LM benefits & desired outcomes
6. Rank LM advantages & positive attributes
7. Rank LM disadvantages & negative attributes
8. Rank and weight LM alternatives overall
Farmer’s perceptions of cost & input requirements

- Most farmers face difficulties in accessing labor, bought inputs and technical knowhow
- These requirements vary per practice and inform farmers’ preferences

Land management cost/input requirements

Relative difficulty in accessing or affording costs/inputs

- Always v. difficult
- Often difficult
- Usually possible
- Always v. easy

Shows average scoring by farmers
Farmers emphasize the **importance of soil fertility and food supply** effects in shaping the relative viability of practices.

Farmers prefer techniques which can assist in **evening out or overcoming food and cash shortages across the year**.
Overall preference of practices

Shows average weight attributed according to overall preference relative to other land management practices. Note that total exceeds 100%, because interviews cover different combinations of land management practices.
Calculating “attainable impact” across the five districts

1. Number of farm households of each farm type
   ~ rural population / HH-size * farm type %

<table>
<thead>
<tr>
<th></th>
<th>Poor female-headed</th>
<th>Small-scale subsistence</th>
<th>Medium-scale dairy</th>
<th>Medium-scale horticulture</th>
<th>Large-scale commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>6</td>
<td>52</td>
<td>7</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>Number HHs</td>
<td>37,563</td>
<td>351,290</td>
<td>48,426</td>
<td>84,009</td>
<td>144,208</td>
</tr>
</tbody>
</table>

2. Adoption rates (% of the HHs likely to adopt the specific intervention) per farm type

   ~ ELMO

<table>
<thead>
<tr>
<th></th>
<th>Compost only</th>
<th>CA</th>
<th>Lime and compost</th>
<th>Lime and NPK</th>
<th>Napier strips</th>
<th>Vetiver strips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost and manure score</td>
<td>35</td>
<td>15</td>
<td>30</td>
<td>27</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Residue incorporation score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(the lowest of the CA components)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inorganic fertilizer score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>minus 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Napier strips score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass strip score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

20% or
Calculating “attainable impact” across the five districts

3. Number of adopting farms $\times$ estimated impact per farm

<table>
<thead>
<tr>
<th></th>
<th>Compost only</th>
<th>Conservation Agriculture</th>
<th>Lime and compost</th>
<th>Lime and NPK</th>
<th>Napier strips</th>
<th>Vetiver strips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-scale commercial</td>
<td>0.32M</td>
<td>0.56M</td>
<td>0.50M</td>
<td>0.53M</td>
<td>0.80M</td>
<td>0.73M</td>
</tr>
<tr>
<td>Medium-scale dairy</td>
<td>0.47M</td>
<td>0.58M</td>
<td>0.78M</td>
<td>0.84M</td>
<td>0.51M</td>
<td>0.48M</td>
</tr>
<tr>
<td>Medium-scale horticulture</td>
<td>0.31M</td>
<td>0.66M</td>
<td>0.47M</td>
<td>0.49M</td>
<td>0.60M</td>
<td>0.63M</td>
</tr>
<tr>
<td>Poor female-headed</td>
<td>0.25M</td>
<td>0.75M</td>
<td>0.23M</td>
<td>0.23M</td>
<td>0.60M</td>
<td>0.63M</td>
</tr>
<tr>
<td>Small-scale subsistence</td>
<td>1.41M</td>
<td>0.46M</td>
<td>2.11M</td>
<td>2.11M</td>
<td>0.44M</td>
<td>0.20M</td>
</tr>
</tbody>
</table>
## Importance of expected adoption rates

<table>
<thead>
<tr>
<th></th>
<th>Compost only</th>
<th>Conservation Agriculture</th>
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<th>Lime and NPK</th>
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<th>Vetiver strips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-scale commercial</td>
<td>0.55M</td>
<td>0.57M</td>
<td>0.74M</td>
<td>0.80M</td>
<td>0.66M</td>
<td>0.57M</td>
</tr>
<tr>
<td>Medium-scale dairy</td>
<td>1.17M</td>
<td>0.51M</td>
<td>1.17M</td>
<td>1.14M</td>
<td>0.59M</td>
<td>0.57M</td>
</tr>
<tr>
<td>Medium-scale horticulture</td>
<td>0.55M</td>
<td>0.88M</td>
<td>0.71M</td>
<td>0.56M</td>
<td>0.03M</td>
<td>0.08M</td>
</tr>
<tr>
<td>Poor female-headed</td>
<td>0.76M</td>
<td>0.56M</td>
<td>0.51M</td>
<td>0.08M</td>
<td>0.08M</td>
<td>0.08M</td>
</tr>
<tr>
<td>Small-scale subsistence</td>
<td>2.66M</td>
<td>3.82M</td>
<td>3.17M</td>
<td>2.85M</td>
<td>0.53M</td>
<td>0.08M</td>
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</tbody>
</table>
## Trade-offs with GHG emissions

### AME days

<table>
<thead>
<tr>
<th></th>
<th>Compost only</th>
<th>Conservation Agriculture</th>
<th>Lime and compost</th>
<th>Lime and NPK</th>
<th>Napier strips</th>
<th>Vetiver strips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-scale commercial</td>
<td>0.12T</td>
<td>0.11T</td>
<td>0.13T</td>
<td>0.13T</td>
<td>0.21M</td>
<td>0.55M</td>
</tr>
<tr>
<td>Medium-scale dairy</td>
<td>1.17M</td>
<td>0.12T</td>
<td>1.17M</td>
<td>0.12M</td>
<td>0.55M</td>
<td>0.00M</td>
</tr>
<tr>
<td>Medium-scale horticulture</td>
<td>0.50M</td>
<td>0.00M</td>
<td>0.50M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
</tr>
<tr>
<td>Poor female-headed</td>
<td>2.56M</td>
<td>0.00M</td>
<td>2.56M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
</tr>
<tr>
<td>Small-scale subsistence</td>
<td>2.17M</td>
<td>0.00M</td>
<td>2.17M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
</tr>
</tbody>
</table>

### GHG emissions

<table>
<thead>
<tr>
<th></th>
<th>Compost only</th>
<th>Conservation Agriculture</th>
<th>Lime and compost</th>
<th>Lime and NPK</th>
<th>Napier strips</th>
<th>Vetiver strips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-scale commercial</td>
<td>0.05M</td>
<td>0.03M</td>
<td>0.06M</td>
<td>0.06M</td>
<td>0.00M</td>
<td>0.00M</td>
</tr>
<tr>
<td>Medium-scale dairy</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
</tr>
<tr>
<td>Medium-scale horticulture</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
</tr>
<tr>
<td>Poor female-headed</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
</tr>
<tr>
<td>Small-scale subsistence</td>
<td>0.02M</td>
<td>0.00M</td>
<td>0.02M</td>
<td>0.00M</td>
<td>0.00M</td>
<td>0.00M</td>
</tr>
</tbody>
</table>
Trade-offs with soil fertility

AME days

N Balance
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Biophysical monitoring and evaluation – N$_2$O fluxes

• Overall, nitrous oxide emissions were small

• Omitting tillage (ZT) or retaining residues did not have any impact on emissions.

• Retaining residues and applying manure increased emissions early in the season in April on farmer fields if not tilled (ZT).

• Use of controlled release urea fertilizer resulted in higher emissions in May.
• Liming nearly doubled labile P in soils which had not received any fertilizer for 12 years. But, that still did not bring these soils out of severe P deficiency.

• Fertilized soils with comparably higher initial available P did not show such trend.

• Liming of acid and P-fixing soils is not a substitute for application of sufficient amounts of organic or inorganic P-fertilizer.
Biophysical monitoring and evaluation – SOC dynamics

- Neither ISFM nor CA could prevent soil organic carbon (SOC) topsoil contents from declining over time
- However, manure application (as part of ISFM), as well as residue retention and omitting tillage (as part of CA) decreased SOC losses
- Land use history prior to installation of CIAT's long-term trials, i.e. the state of soil health/degradation, plays a major role in the speed of decline of SOC
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CSA prioritization workshop

Workshop objectives
1. To understand the desired outcomes by different stakeholders used to prioritize agricultural practices across the 5 farm types in Western Kenya;
2. To develop a prioritized list of CSA practices farmers would like to implement;
3. To evaluate the climate smartness of prioritized practices
4. To understand benefits, challenges, barriers and tradeoffs in adopting prioritized practices
Long list of agricultural practices in Western Kenya

1. Push and pull
2. Fallowing
3. Dry planting
4. Certified seed
5. Grass strips e.g. vertiver grass
6. Organic manure
7. Cover crop
8. Conservation agriculture
9. Use of herbicides
10. Organic manure
11. Water harvesting
12. Intercropping
13. Crop rotation
14. Terracing
15. Mulching
16. Minimum tillage
17. Incorporate residue
18. Composting
19. Agroforestry
20. Liming
Current and long-term desired CSA objectives by stakeholders in Western Kenya

CSA Objectives: Current
- Productivity: 75%
- Adaptation: 20%
- Mitigation: 5%

CSA Objectives: Long-Term
- Productivity: 50%
- Adaptation: 40%
- Mitigation: 10%
### Pairwise ranking of practices

<table>
<thead>
<tr>
<th>Small scale mixed subsistence</th>
<th>Medium scale mixed with commercial horticulture</th>
<th>Medium scale mixed with commercial dairy</th>
<th>Medium scale mixed with commercial cereal</th>
<th>Large scale commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Incorporate residues</td>
<td>5. Composting</td>
<td></td>
<td>5. Terracing</td>
<td>5. Terracing</td>
</tr>
</tbody>
</table>
By **IMPLEMENTING** the practice what are the **expected changes** in the following indicators?

<table>
<thead>
<tr>
<th>Indicator (Average)</th>
<th>Metric</th>
<th>Indicator assessment (-10 to 10 scale)</th>
<th>Pillar Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>P Yield (Maize)</td>
<td>Δ kg/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P Yield variability (Maize)</td>
<td>Standard Deviation (kg/ha/yr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P Income generated from Maize production</td>
<td>$/kg/year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Household income spent on food</td>
<td>$/month/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Soil lost through erosion</td>
<td>t/acre/year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Content of soil organic matter (SOM)</td>
<td>% SOM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Quantity of water used per unit of product (water use efficiency)</td>
<td>L/kg product/season</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M Aboveground Biomass</td>
<td>t/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M Belowground Biomass</td>
<td>t/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M Total Soil Carbon</td>
<td>% SOC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Climate smartness assessment

<table>
<thead>
<tr>
<th>Farm type</th>
<th>Practice</th>
<th>Productivity</th>
<th>Adaptation</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small scale mixed</td>
<td>Farm yard manure</td>
<td>5</td>
<td>2.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Small scale mixed</td>
<td>Conservation agriculture</td>
<td>5.2</td>
<td>2.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Small scale mixed</td>
<td>Composting</td>
<td>4.7</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Medium-mixed-hort</td>
<td>Intercropping</td>
<td>3.5</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Medium-mixed-hort</td>
<td>Certified seed</td>
<td>6.8</td>
<td>3.2</td>
<td>N/A</td>
</tr>
<tr>
<td>Medium-mixed-hort</td>
<td>Crop rotation</td>
<td>3.5</td>
<td>2.2</td>
<td>1</td>
</tr>
<tr>
<td>Medium-mixed-dairy</td>
<td>Farm yard manure</td>
<td>3.8</td>
<td>3.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Medium-mixed-dairy</td>
<td>Agroforestry</td>
<td>4.5</td>
<td>2.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Medium-mixed-dairy</td>
<td>Inorganic fertilizer</td>
<td>3.5</td>
<td>1.5</td>
<td>-3.3</td>
</tr>
<tr>
<td>Medium-mixed-cereal</td>
<td>Crop rotation</td>
<td>6.5</td>
<td>0.5</td>
<td>N/A</td>
</tr>
<tr>
<td>Medium-mixed-cereal</td>
<td>Herbicide</td>
<td>5</td>
<td>2.2</td>
<td>-0.3</td>
</tr>
<tr>
<td>Medium-mixed-cereal</td>
<td>Inorganic fertilizer</td>
<td>7</td>
<td>1.2</td>
<td>-4.3</td>
</tr>
<tr>
<td>Large scale commercial</td>
<td>Conservation agriculture</td>
<td>5.5</td>
<td>3.6</td>
<td>1.2</td>
</tr>
<tr>
<td>Large scale commercial</td>
<td>Liming</td>
<td>2.5</td>
<td>0.7</td>
<td>N/A</td>
</tr>
<tr>
<td>Large scale commercial</td>
<td>Agroforestry</td>
<td>5.5</td>
<td>3.5</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Farmers preferred indicators

a) Yield
b) Yield variability
c) Income
d) income spent on food per season
e) soil organic matter
f) amount of water available for production
## Cost-benefit analysis

<table>
<thead>
<tr>
<th>Farm typology</th>
<th>CSS Practice</th>
<th>NPV (9%)</th>
<th>IRR (%)</th>
<th>Payback Period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small-scale mixed subsistence</td>
<td>Farmyard manure</td>
<td>2,487</td>
<td>65</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Intercropping</td>
<td>6,718</td>
<td>67</td>
<td>3</td>
</tr>
<tr>
<td>Medium-scale mixed commercial dairy</td>
<td>Agroforestry</td>
<td>4429</td>
<td>47</td>
<td>4</td>
</tr>
<tr>
<td>Medium-scale mixed commercial horticulture</td>
<td>Improved seeds</td>
<td>5320</td>
<td>61</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Composting</td>
<td>2342</td>
<td>36</td>
<td>5</td>
</tr>
<tr>
<td>Medium-scale mixed commercial cereals</td>
<td>Improved seeds</td>
<td>7,733</td>
<td>60</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Inorganic fertilizer</td>
<td>6,949</td>
<td>60</td>
<td>5</td>
</tr>
<tr>
<td>Large-scale commercial</td>
<td>Liming</td>
<td>5656</td>
<td>44</td>
<td>4</td>
</tr>
</tbody>
</table>
### Cost-benefit analysis

Estimated implementation, maintenance and operation cost by practice and farm typologies across all counties

<table>
<thead>
<tr>
<th>Farm typology</th>
<th>CSS Practice</th>
<th>Implementation cost (US$ ha(^{-1}))</th>
<th>Maintenance cost (US$ ha(^{-1}) yr(^{-1}))</th>
<th>Operation cost (US$ ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small-scale mixed subsistence farming</td>
<td>Organic manure</td>
<td>688</td>
<td>211</td>
<td>250</td>
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<tr>
<td></td>
<td>Intercropping</td>
<td>582</td>
<td>413</td>
<td>294</td>
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<tr>
<td>Medium-scale mixed with commercial dairy</td>
<td>Agroforestry</td>
<td>616</td>
<td>294</td>
<td>173</td>
</tr>
<tr>
<td>Medium-scale mixed with commercial horticulture</td>
<td>Improved seeds</td>
<td>1,092</td>
<td>886</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Organic manure</td>
<td>1,049</td>
<td>209</td>
<td>316</td>
</tr>
<tr>
<td>Medium-scale mixed with commercial cereals</td>
<td>Improved seeds</td>
<td>1,560</td>
<td>410</td>
<td>271</td>
</tr>
<tr>
<td></td>
<td>Inorganic fertilizer</td>
<td>1,659</td>
<td>787</td>
<td>270</td>
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<tr>
<td>Large-scale commercial farming</td>
<td>Liming</td>
<td>371</td>
<td>301</td>
<td>467</td>
</tr>
<tr>
<td>Climate Smartness</td>
<td>Outcome Indicators</td>
<td>Scaling potential</td>
<td></td>
<td></td>
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<tr>
<td>-------------------</td>
<td>-------------------</td>
<td>------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delineate Geographic Area</td>
<td>Identify Farm Types</td>
<td>Agree on Key Indicators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>List Practices to Consider:</td>
<td>• WOCAT Database</td>
<td>• CSA Compendium</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Expert Assessment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expert Scoring of Long List of Practices</td>
<td>Farm &amp; Household Modeling</td>
<td>Biophysical Assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost-Benefit Analysis</td>
<td>Evaluation of Land Management Options</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stakeholder Consultation &amp; Workshops</td>
<td>Project Design &amp; Implementation at Scale</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Outline

• Introduction and objectives of the climate-smart soils (CSS) project

• Climate-smartness evaluation
  • Farm Typology
  • Rapid Climate Smartness Assessment (Kalkulator)
  • Evaluation of Land Management Options (ELMO)
  • Attainable impact

• Biophysical assessment

• CSA prioritization framework
  • CSA identification and prioritization workshop
  • Economic assessment, CBA
  • Revised framework

• Recommendations
Recommendations

• Productivity similar, except female-headed much lower. Dairy also lower than others. Large commercial coffee farmer contributes less to food security.

• Diversity of production base varies – dairy and horticulture higher number of calorie-producing activities.

• Poor female-headed household dependent on off-farm activities for survival.

• N balances tend to be negative except for commercial farmers using inputs, and farms with high livestock density. Nutrient input management of concern.

• Soil erosion very little, concern only from 20t/ha -> but this is only true for the sampled farms which were not on slopes.

• GHG emissions driven by livestock (enteric fermentation and manure mgt).

• Total emissions low: Germany 9t/capita, USA 16t/capita, Kenya 0.3t/capita.
Recommendations II

• Grass strip interventions need additional nutrient inputs, otherwise trade-off with N balance.
• Synergy production and GHG is rare. Different impacts on different farm types – eg compost leads to GHG decrease on commercial farm, but increase on all others
• Increases in GHG emissions are small.
• With all agriculture you lose C – with CA you lose less
• No tillage without residue retention will lead to a yield penalty
• Most important: soil fertility, critical food/cash crops
• Most important challenges: soil acidity, availability, requires transport
• Most preferred practices: compost and manure, inorganic fertilizers – soil erosion techniques either not mentioned at all (tillage) or not preferred (grass strips)
• CA is perceived as a technology for commercial farmers due to herbicide use (weeds increase without tillage)
Questions

• Is this analysis useful and relevant to your work?
• How could you use these results in your work?
• Has this study influenced your thinking and practice already, and if yes how?
Thank you!