Adaptation priority sectors: Agriculture and forestry

Henry Neufeldt
World Agroforestry Centre (ICRAF)
Correlation between GDP and rainfall in Zimbabwe
Globally, residual damages can be limited with 2 degrees and adaptation

(Source: Hof et al., 2010)
Figure 7-5 | Summary of projected changes in crop yields, due to climate change over the 21st century. The figure includes projections for different emission scenarios, for tropical and temperate regions, and for adaptation and no-adaptation cases combined. Relatively few studies have considered impacts on cropping systems for scenarios where global mean temperatures increase by 4°C or more. For five timeframes in the near-term and long-term, data (n=1090) are plotted in the 20-year period on the horizontal axis that includes the midpoint of each future projection period. Changes in crop yields are relative to late-20th-century levels. Data for each timeframe sum to 100%. Projections taken from Abraha and Savage, 2006; Alexandrov and Hoogenboom, 2000; Arndt et al., 2011; Berg et al., 2013; Brassard and Singh, 2008; Brassard and Singh, 2007; Butt et al., 2005; Calzadilla et al., 2009; Chhetri et al., 2010; Ciscar et al., 2011; Deryng et al., 2011; Giannakopoulos et al., 2009; Hermans et al., 2010; Iqbal et al., 2011; Izaurralde et al., 2005; Kim et al., 2010; Lal, 2011; Li et al., 2011; Lobell et al., 2008; Moriondo et al., 2010; Müller et al., 2010; Osborne et al., 2013; Peltonen-Sainio et al., 2011; Piao et al., 2010; Ringler et al., 2010; Rowhani et al., 2011; Schlenker and Roberts, 2009; Shuang-He et al., 2011; Southworth et al., 2000; Tan et al., 2010; Tao & Zhang, 2010; Tao and Zhang, 2011; Tao et al., 2009; Thornton et al., 2009; Thornton et al., 2010; Thornton et al., 2011; Tingem and Rivington, 2009; Tingem et al., 2008; Walker and Schulze, 2008; Wang et al., 2011; Xiong et al., 2007; Xiong et al., 2009.
Farmers most interested in reducing food insecurity

No long- or medium-term planning possible under food insecure situation

Tree planting (and other investments in livelihood improvements) only after basic food security is guaranteed

Food insecurity rose by at least one month (above on average 3 months) during drought and flooding

Coping strategies lead into ‘poverty trap’

Agroforestry reduced food insecurity by about 1 month

### Farmer climate coping strategies

<table>
<thead>
<tr>
<th></th>
<th>Reduce Quantity, Quality or # of meals</th>
<th>Community or family support</th>
<th>Help from Gov, NGO, Church</th>
<th>Borrow money</th>
<th>Casual Labor</th>
<th>Sell possessions or livestock</th>
<th>Consume Seeds</th>
<th>Children attend school less</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All #s in %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lower Nyando</strong></td>
<td>85</td>
<td>30</td>
<td>42</td>
<td>32</td>
<td>28</td>
<td>72</td>
<td>72</td>
<td>38</td>
</tr>
<tr>
<td><strong>Middle Nyando</strong></td>
<td>38</td>
<td>23</td>
<td>18</td>
<td>37.5</td>
<td>25</td>
<td>40</td>
<td>61</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Thorlakson and Neufeldt 2012
Climate-smart agriculture

Food Systems

Adaptation

Short term ↔ Long term

Efficiency

Fairness

Small scales

Large scales

Short term

Long term

Short term ↔ Long term

Efficiency

Fairness

Small scales

Large scales

Short term ↔ Long term
Examples of climate-smart agriculture practices

<table>
<thead>
<tr>
<th>Crops</th>
<th>Livestock</th>
<th>Agroforestry</th>
</tr>
</thead>
<tbody>
<tr>
<td>No tillage, direct seeding</td>
<td>Increased feeding efficiency</td>
<td>Multipurpose trees on farms</td>
</tr>
<tr>
<td>Rotations with legumes</td>
<td>Improved rangeland management</td>
<td>Nitrogen-fixing trees, bushes, fodder trees</td>
</tr>
<tr>
<td>Intercropping with legumes</td>
<td>Efficient treatment of manure</td>
<td>Improved fallows</td>
</tr>
<tr>
<td>New varieties: shorter cycle,</td>
<td>Improved livestock health</td>
<td>Hedges, windbreaks, shelterbelts, live fences</td>
</tr>
<tr>
<td>drought tolerant, etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved storage &amp;</td>
<td>Animal husbandry improvements</td>
<td>Fruit orchards</td>
</tr>
<tr>
<td>processing technologies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Many interventions can be climate-smart somewhere
But none are likely climate-smart everywhere
### Examples of climate-smart agriculture practices

<table>
<thead>
<tr>
<th>Water management</th>
<th>Soils management</th>
<th>Fisheries &amp; Aquaculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water storage – e.g. water pans</td>
<td>Conservation agriculture and no-till</td>
<td>Saline resistant species</td>
</tr>
<tr>
<td>Alternate wetting and drying (rice)</td>
<td>Stone bunds</td>
<td>Increased feeding efficiency</td>
</tr>
<tr>
<td>Dams, pits, retaining ridges</td>
<td>Planting pits (zai)</td>
<td>Integration of aquaculture in farms</td>
</tr>
<tr>
<td>Improved irrigation (drip)</td>
<td>Mulching</td>
<td>Low energy fuel efficient fishing</td>
</tr>
</tbody>
</table>

Many interventions can be climate-smart somewhere

But *none* are likely climate-smart everywhere
Evergreen agriculture with *Faidherbia albida*

<table>
<thead>
<tr>
<th>Country</th>
<th>Zambia</th>
<th>Malawi</th>
<th>Niger</th>
<th>B Faso</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evergreen Agriculture System</td>
<td>Conservation farming with <em>Faidherbia</em> fertilizer trees</td>
<td>Portfolio of agroforestry species including a range of fertilizer trees</td>
<td>Assisted Natural Regeneration of <em>Faidherbia</em> + other trees</td>
<td><em>Zai</em> planting pits + ANR&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Farming system</td>
<td>Maize, cotton</td>
<td>Maize</td>
<td>Millets, sorghum integrated with livestock</td>
<td>Millets, sorghum</td>
</tr>
<tr>
<td>Scaling-up methods</td>
<td>Extension with lead farmer model</td>
<td>Whole-village mobilization</td>
<td>Community-based resource management institutions</td>
<td></td>
</tr>
<tr>
<td>Extent of uptake</td>
<td>&gt;160,000 farms</td>
<td>&gt;120,000 farms</td>
<td>&gt;4.8 mha</td>
<td>&gt;200,000 ha</td>
</tr>
</tbody>
</table>

<sup>a</sup> Assisted Natural Regeneration
Integrated livestock – forest systems

Advantages:
- increased production of meat without the opening up of large new areas of land;
- reduced weeding costs;
- reduced surface erosion;
- production of organic manure to fertilize the trees and reduce the cost of inorganic fertilizers;
- speeded rate of nutrient cycle through urine and manure;
- provision of additional income to plantation cultivators through increased productivity per unit of land; and
- savings in foreign exchange on fertilizer and meat imports.

Soybean after Brachiaria
Rio Verde, GO

Very high C input through pasture residues every time the rotation restarts
Examples of no-till practices in different countries

31 SEMEATO Land Master No-till machine at seeding in Mato Grosso, Brazil, on the Farm of Mr. Mazzuti
240 m. working width!
7.8 m per Machine

No-tillage in Tanzania
System of rice intensification as an example of improved nutrient and water management

Figure 4 Resistance to biotic and abiotic stresses based on alternative crop management: two adjacent rice paddy fields in Crawuk village, Ngawi district, East Java, Indonesia, after they were both hit by a brown planthopper (BPH) attack and then by a tropical storm in June 2011. Paddy field on left, planted with an improved rice variety (Ciherang) and using inorganic fertilizer and agrochemical protection, gave almost no yield because of BPH burn and lodging. From the field on the right, 1,000 m² in area, planted with an aromatic unimproved variety (Sinantur) and having organic SRI management, 800 kg was harvested, a yield of 8 tons/ha. Picture given to the author by Ms. Miyatty Jannah, the farmer who managed the field on right.

*Uphoff, 2012*
Review of SRI management impacts on yield, water saving, costs of production and farmer income per ha in 13 countries

Average:
+50% yield
-37.5% water use
-16% costs
+94% income

Table 1 Review of SRI management impacts on yield, water saving, costs of production, and farmer income per ha in 13 countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Farmers (N) or Trials/Area</th>
<th>Conventional yield (t/ha)</th>
<th>SRI yield (t/ha)</th>
<th>Yield increase (%)</th>
<th>Water saving (%)</th>
<th>Impact on cost per ha (%)</th>
<th>Impact on income per ha (%)</th>
<th>Coverage of evaluation and agency doing study [source of data]</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFGHANISTAN</td>
<td>42*</td>
<td>5.6</td>
<td>9.3</td>
<td>59%</td>
<td>NM</td>
<td>NM</td>
<td>NM</td>
<td>Aga Khan Foundation program in Balkh district [28]</td>
</tr>
<tr>
<td>BANGLADESH</td>
<td>1,073*</td>
<td>5.44</td>
<td>6.86</td>
<td>26%</td>
<td>NM</td>
<td>-9%</td>
<td>+59%</td>
<td>2-year study by NGOs and Syngenta under IRRI program auspices [24]</td>
</tr>
<tr>
<td>CAMBODIA</td>
<td>500*</td>
<td>1.63</td>
<td>2.29</td>
<td>41%</td>
<td>Rainfed</td>
<td>-56%</td>
<td>+74%</td>
<td>5-province study done for GTZ [25]</td>
</tr>
<tr>
<td>Experenced farmers</td>
<td>120*</td>
<td>1.34</td>
<td>2.75</td>
<td>105%</td>
<td>Rainfed</td>
<td>-47%</td>
<td>+98%</td>
<td>Study of all 3-year SRI users by CEDAC [16]</td>
</tr>
<tr>
<td>CHINA</td>
<td>82*</td>
<td>6.6</td>
<td>9.37</td>
<td>42%</td>
<td>44%</td>
<td>-7.4%</td>
<td>+64%</td>
<td>Village study by China Agricultural University in Sichuan province [27]</td>
</tr>
<tr>
<td>Schan province</td>
<td>Total area 2004 to 2010: 301,967 ha</td>
<td>7.7</td>
<td>9.5</td>
<td>29%</td>
<td>25.6%</td>
<td>NR</td>
<td>Additional income: US$320 million</td>
<td>Provincial Department of Agriculture, 2004 to 2010 [28]</td>
</tr>
<tr>
<td>INDIA</td>
<td>108*</td>
<td>4.12</td>
<td>5.47</td>
<td>32%</td>
<td>Rainfed</td>
<td>-35%</td>
<td>+67%</td>
<td>IWMI-India programme study in W. Bengal [29]</td>
</tr>
<tr>
<td>Andhra Pradesh state</td>
<td>1,525*</td>
<td>6.31</td>
<td>8.73</td>
<td>34%</td>
<td>40%</td>
<td>NM</td>
<td>NM</td>
<td>Evaluations by AP state university ANGRAU [30]</td>
</tr>
<tr>
<td>INDONESIA</td>
<td>12,133*</td>
<td>4.27</td>
<td>7.61</td>
<td>78%</td>
<td>40%</td>
<td>-20%</td>
<td>&gt;100%</td>
<td>On-farm trials managed by Nippon Koei TA team, 2002 to 2006 [31]</td>
</tr>
<tr>
<td>KENYA</td>
<td>On-station trials</td>
<td>6.2</td>
<td>7.6</td>
<td>29%</td>
<td>28.2%</td>
<td>NM</td>
<td>NM</td>
<td>Mwea Irrigation scheme trials, 3 replications [32]</td>
</tr>
<tr>
<td>Additional trials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mwea Irrigation scheme trials, 4 replications [33]</td>
</tr>
<tr>
<td>MALI</td>
<td>53*</td>
<td>5.5</td>
<td>9.1</td>
<td>60%</td>
<td>10%</td>
<td>+15%</td>
<td>+108%</td>
<td>Timbuctu region under Africare program [34]</td>
</tr>
<tr>
<td>MYANMAR</td>
<td>612*</td>
<td>2.1</td>
<td>4.4</td>
<td>110%</td>
<td>Rainfed</td>
<td>+0.2%</td>
<td>8.7 times more</td>
<td>FFS results in Kachin and Shan States, 3 years [35]</td>
</tr>
<tr>
<td>NEPAL</td>
<td>412*</td>
<td>3.3</td>
<td>6.1</td>
<td>82%</td>
<td>43%</td>
<td>-22%*</td>
<td>+163%</td>
<td>District agricultural extension program, Monang [36]</td>
</tr>
<tr>
<td>Far Western region</td>
<td>890*</td>
<td>4.01</td>
<td>7.58</td>
<td>&gt;60%</td>
<td>32%</td>
<td>+164%</td>
<td></td>
<td>EU-FAO Food Facility Programme [37,38]</td>
</tr>
<tr>
<td>PANAMA</td>
<td>46*</td>
<td>3.44</td>
<td>4.75</td>
<td>38%</td>
<td>71-89%</td>
<td>NM</td>
<td></td>
<td>10 communities, evaluation by NGO [39]</td>
</tr>
<tr>
<td>SRI LANKA</td>
<td>120*</td>
<td>3.84</td>
<td>5.52</td>
<td>44%</td>
<td>24%</td>
<td>-12%</td>
<td>+104%</td>
<td>WMI study in 2 districts [40]</td>
</tr>
<tr>
<td>VIETNAM</td>
<td>1,274*</td>
<td>5.58</td>
<td>6.79</td>
<td>22%</td>
<td>33%</td>
<td>-30%</td>
<td>+36%</td>
<td>MARD FFS results from 13 districts [41]</td>
</tr>
</tbody>
</table>

Total N and Averages: 18,870* 4.77 7.12 50% 37.5% -16% 94%b

NM: Not measured, NR: Not reported, FFS: Farmer Field Schools.
*Not including Sichuan/China data; bNot including Myanmar data.
* Based on random samples; cResults from all farmers using SRI in area, no sampling involved.
* Labor-saving hand weeding were not yet available in district to reduce labor inputs and costs.
* Extension personnel were promoting the purchase of modern seeds and fertilizer simultaneously with SRI methods.
* 50% increase in the village with normal rainfall, 12% in the drought-stressed village.

Uphoff, 2012
Making climate-smart agriculture work for the poor

This brief focuses on the challenges in making climate-smart agricultural production work for the poor, who will be the most vulnerable to climate impacts. It offers recommendations to overcome constraints, as even small management changes can have significant income and livelihood benefits.

What is climate-smart agriculture?

Agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals.

Food and Agriculture Organization of the United Nations
Barriers to adoption of CSA in smallholder agriculture

- Provide an enabling legal and political environment
- Improve market accessibility
- Involve farmers in the project-planning process
- Improve access to knowledge and training
- Introduce more secure tenure
- Overcome the barriers of high opportunity costs to land
- Improve access to farm implements and capital

Thorlakson and Neufeldt, 2012
Innovation and food security

Relationship between innovativeness (number of farming system changes) and household food security (number of food deficit months). Error bars indicate the 95% confidence interval of the mean.

Kristjanson et al 2012
Financial benefits of no-till wheat production in northern Kazakhstan

Derpsch et al 2010
## Constraints: insecure tenure

<table>
<thead>
<tr>
<th>Economic, Environmental and Social Impacts</th>
<th>Unadjud</th>
<th>Freehold</th>
<th>Tenure Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net returns to land (($ \text{ ha}^{-1} \text{ y}^{-1}))</td>
<td>$126</td>
<td>$288</td>
<td>2.28</td>
</tr>
<tr>
<td>Woody crops, woodlots etc (ha km(^{-2}))</td>
<td>5.4</td>
<td>25.6</td>
<td>4.7</td>
</tr>
<tr>
<td>Hedgerows (km km(^{-2}))</td>
<td>5.2</td>
<td>23.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Social cost from embedding</td>
<td>-$40</td>
<td>$30</td>
<td>$70</td>
</tr>
<tr>
<td>Social &quot;tax&quot;</td>
<td>-32%</td>
<td>+10%</td>
<td></td>
</tr>
</tbody>
</table>

Norton-Griffiths 2012
Then...
Zinder, Niger, 1980s
... and now.
Zinder, Niger, today.

These 5 million hectares of new agroforest parklands are yielding

500,000 tonnes

more than before.

(Reij, 2012)
The reconstruction of the dynamics in Shinyanga

The reference state
- Sustainable agropastoral livelihood system
- Ngitili (fodder bank system)
- Indigenous Miombo and acacia woodlands

1930

The degradation phase
- Tse tse fly eradication (clearing of woodlands)
- Cash crops expansion
- Overstocking
- Increasing wood demand
- Deforestation for villagization
- Insecure tenure rights

1986

The restoration phase
- Ngitili
- Onfarm tree conservation
- Improved fallows
- Rotational woodlots
- Community empowerment
- Long-term investment from NORAD and ICRAF
- Insecure tenure rights
HASHI (Shinyanga Soil Conservation Programme) (1986-2004)

Committed Government
Committed People
Committed Donors
Committed partners

Empowered communities
Recognition of local knowledge and practices

611 ha of managed Ngitili in 1986

378,000 ha restored area in 2005
The Benefits

**Economic values** *(Monela et al. 2005)*
Per capita economic value: 168 USD/year
Rural per capita expenditure: 102 USD/year

**Other ES benefits**
Hydrological functions:
Dam construction and water management ("Water markets")
Soil management:
Erosion control
SOM build-up

**Carbon sequestration**
1986 - 611 ha (27,428 t C)
2005 - 377,756 ha (17 M t C)

REDD+ piloting is already ongoing!!

**Social and Intrinsic values**
- Social cohesion
- ‘Social security’

**Biodiversity conservation**
Bird species reemerged: 22-65
Mammal species reemerged: 10
Plant species in restored Ngitili: 152
Scalability of context specific solutions
Which Trees and Where?

Agroforestry Database

Free Text Search
Enter Search text here: 

Distribution Range
Select country name
--Select name--

Native Exotic

Products and Services

Food 
Fodder 
Agriculture 
Fuel 
Timber 
Wax 
Lipids 
Gums/Resins 
Tannins/DyeStuffs 

Intercropping 
Shade/shelter 
Reclamation 
Boundary/Barrier 
Ornamental 
Soft Fertility 
Poison 
Latex/Rubber 
Fibres

Select species name that starts with.. 
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
Welcome to the Landscapes Portal!

Our mission is to further the application of GeoScience in assessing coupled social-ecological processes in landscapes.

The Landscapes Portal provides users with a platform for visualizing and sharing spatial data and maps, as well as map stories.

Explore spatial data
Interative mapping
Tools

Latest Blog

Mapping the source of soil erosion
Conventional soil erosion models are

Add geotagged photos to

Want to know what we are up to?
In the GeoScience Lab we are constantly pushing the envelope on what we do with models and maps. This presentation gives you an idea of what we are up to at the moment:

Mapping soil functional properties using multilevel models
In this document we present examples of R functions and scripts that may be used to generate local maps of soil functional
Land Health Surveillance

Sentinel sites
Randomized sampling schemes

Prevalence, Risk factors, Digital mapping

Consistent field protocol

Coupling with remote sensing

Soil spectroscopy
Gender and Inclusion Toolbox: Participatory Research in Climate Change and Agriculture

- Gender and inclusion for resilience*
  - Moving from sex disaggregated diagnostic research towards informing, catalyzing and targeting adaptation and mitigation solutions to women
  - Finding: Gender norms must be addressed to achieve the SDGs and CGIAR IDO
Good Nursery Practices: A Simple Guide

FODDER FOR A BETTER FUTURE
How agroforestry is helping to transform the lives of smallholder dairy farmers in East Africa

SEEDS OF HOPE
A public-private partnership to domesticate a native tree, Allanblackia, is transforming lives in rural Africa.
Priority Actions:

- **Improve networking and partnership building** for climate adaptation along the value chain by strengthening existing platforms at all levels and explore the role of market incentives in supporting such activities,

- **Develop new, flexible financial products** to support climate-resilient and inclusive **agro-value chains** through capacity building and innovative public-private partnerships,

- **Invest in climate-resilient infrastructures** such as roads, irrigation systems, storage facilities and telecommunications should remain a top priority to support agro-value chain development and build productive capacities in a changing climate.
• Up-front public sector finance needed to turn projects viable
• Projects build institutional capacity
• Projects deliver food security and adaptation with mitigation co-benefits
• Insurance schemes provide safety nets against falling into the poverty trap
• Combining many and diverse investments in land can increase returns and drive large-scale investment in sustainable NRM
• Robust M+E frameworks are needed to quantify how different CSA practices reduce climate risk

Foster et al 2013
Local Governance and Adapting to CC in sub-Saharan Africa (LGACC)

Assessments of adaptive capacity, land and natural resource governance, social inclusion

2 sites with minimal biophysical variance

Kenya site in Laikipia-Samburu and Burkina Faso site in Centre-South

Adaptation case studies to understand innovation(s)

Pairing of insights with climate scenarios for future climate change

Development of decision-support tools
Climate Information Services

- Research questions:
  - What types of climate information services do farmers need to be more resilient to climate change?
  - What difference do climate information services make in the livelihoods of farmers?
- Development of tools and methods to capture the value added of climate information services with projects in Tanzania, Malawi, Rwanda
- Working in partnership with CCAFS, WMO, other international organizations and national stakeholders
Resilience Diagnostic and Decision Support Tool

The SHARED process is comprised of four inter-related phases, applied on a case by case basis. These are tailored to the specific context of decision makers, stakeholders and resources. Working with the Turkana County Government, the National Drought Management Authority (NDMA) and UNICEF, the ICRAF SHARED team is integrating technical and human resources with the development of tools to support informed decision making at various scales.

Working with the Turkana County Government and the National Drought Management Authority (NDMA), ICRAF and UNICEF Kenya have partnered to build capacity and tools for evidence based decision making. Using the ICRAF SHARED facilitation framework, scientific evidence and the capacity and information needs of County decision makers have been fundamental to the design of the diagnostic decision support tool.

The Turkana Resilience Dashboard is custom built by integrating multiple data sources on Turkana and a number of analytical processes to make data that is at varied scales meaningful through different visual forms. Thematic modules such as land health, security and education have been built to allow for easy visualisation of the data to assist with decision making and resilience planning.
Thanks for a future
**Integrated landscape management**

...is based on...

- Alignment of sectoral policies and their coordinated implementation
- Adoption of participatory and people-centred approaches and management structures
- Adequate governance structures and market environment
- Improved knowledge management
- Context specificity

FAO 2013