Improved Livestock Management for Increasing Productivity and Climate Resilience in East Africa

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Dr. Stanley Karanja Ng’ang’a, CIAT
Dr. Gordon Smith, CEADIR
Dr. Todd Crane, ILRI
Moderator: Laurie Ashley, USAID

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Pablo Torres

• CEADIR Chief of Party, Crown Agents USA
• With CEADIR since 2015
• 16 years of international development experience
• Master of Environmental Management from Yale School of the Environment
Welcome to the CEADIR Series and Introduction
Pablo Torres (CEADIR)

Introductory Remarks
Laurie Ashley (USAID Bureau for Resilience and Food Security)

Feasibility of Low Emissions Development Interventions for the East African Livestock Sector: Lessons From Kenya and Ethiopia
Dr. Polly Ericksen (International Livestock Research Institute, ILRI)

CEADIR Cost-Benefit Analysis of Improved Pasture Management Practices in the Oromia Lowlands of Ethiopia: Management Improvements and Methods
Dr. Stanley Karanja Ng’ang’a (International Center for Tropical Agriculture, CIAT)

CEADIR Cost-Benefit Analysis: Assumptions and Results
Dr. Gordon Smith (CEADIR)

Social Differentiation in Climate Change Adaptation: One Community, Multiple Pathways in Transitioning Kenyan Pastoralism
Dr. Todd Crane (ILRI)

Q&A
Laurie Ashley

- Resilience and Climate Adaptation Advisor
  USAID Center for Resilience

- 20 years of experience as technical advisor on
climate adaptation and natural resources management
USAID Approaches to Climate Resilience and Livestock

- USAID’s resilience approach is a systems approach
- Shocks and stressors have intensified over the last decade including
  - Recurrent drought, water scarcity, rising temperatures, loss of common resources and conflict
- Better linking humanitarian, development and peace building programming benefit people and the livestock sector
- USAID Project Examples: PRIME, REVIVE and SAPARM
Intervention Synergies in Livestock Management

• Support opportunities for synergy in animal health and productivity, climate resilience, and climate mitigation

• Healthy animals and sustainable landscapes are more productive and resilient and have lower greenhouse gas emission intensity

• Technical interventions are only as effective as their relevance to and acceptance by local people and cultures

photo credit: Simone Tognetti
Dr. Polly Ericksen

• Led research on sustainable livestock systems at International Livestock Research Institute (ILRI) for the past decade

• Over 25 years of experience on research and development in agriculture and global environmental change in developing countries
Feasibility of Low-Emissions Livestock Production

Ruminant livestock are a major source of methane emissions

- High intensity of emissions per unit of product
- Countries have now committed to reductions in NDCs
- Investment needed to realize these commitments
- Low productivity of livestock in much of Africa an opportunity and concern
Exploiting Yield Gaps Key To Achieve Environmental Benefits In Ruminant Systems

Largest improvements in low-producing animals

Source: Gerber et al, FAO 2013
Sources Of GHG Emissions From Livestock

Source: Dickhoefer et al., 2014

Enteric fermentation
- Choice of diet ingredients
- Improved diet digestibility
- Enhanced feed intake capacity
- Feeding management
- Rumen modifiers

Herd management & performance level
- Choice of animal species/breed
- Genetic selection
- Herd structures
- Health & fertility management

Feed production & storage
- Choice of feed types/origin
- Plant breeding
- Improved harvest methods
- Optimized fertilizer use
- Feed conservation/processing technologies
- Feed waste management

Manure storage & use
- Adapted protein intake
- Reduced protein degradability
- Improved diet digestibility
- Use of fibrous feeds
- Optimized excreta management
- Excreta recycling

Non dairy cattle 55%
Dairy cattle 19%
Buffaloes 11%
Others 3%
Goats 5%
Sheep 7%
Manure left on pasture 17%
Manure applied to soils 2%
Synthetic fertilizer 15%
Rice cultivation 11%
Crop residues 3%
Enteric fermentation 44%
Manure management 8%
Interventions to Reduce Emissions Intensities

• Improvements in feed quality to increase productivity
  • Supplemental fodder from improved forage species – mixed crop-livestock
  • Supplemental feeding with concentrates – intensive dairy
  • Silage from maize – intensive dairy
  • Managed grazing – extensive pastoral
Interventions To Reduce Emissions Intensities (cont’d)

• Manure management
  • Biodigesters for methane capture – intensive (zero grazing) dairy
  • Manure storage in covered heaps – mixed crop-livestock

• Improved animal husbandry
  • Reduce chronic disease burden of intestinal parasites – all systems
  • Reduce age at slaughter – pastoral systems
  • Artificial insemination for more productive breeds – intensive dairy
Greenhouse Gas Mitigation Potential (I)

- Improved feed quality: Opio et al (2016) suggest 26-28% reduction in intensities for lactating cattle
- Gerber et al (2013) suggest 5-13% small ruminants
- High-quality silage: 48% in dairy (Opio)
- Concentrates up to 30% reductions in dairy (Gerber).
Managed grazing – very uncertain
Biodigesters – can avoid 60 to 80% of methane emissions
Manure storage – highly dependent on management but can reduce $\text{N}_2\text{O}$ emissions significantly
Reduce parasite burden – 10% (Kenyon et al Scotland)
AI – unknown
Managed Grazing in Rangelands

• Barriers
  • Require high institutional governance capacity
  • Expansive landscape commitment
  • Long time horizon to see substantial carbon sequestration effects

• Incentives
  • Improve market access to drive intensification
  • Couple with improved herd management and health
Stanley Karanja Ng’ang’a
Ph.D

• Development Economist for Climate Action – Finance and Investment team in Africa at Alliance for Biodiversity International and International Center for Tropical Agriculture (CIAT)

• Previously worked at CIAT and International Livestock Research Institute

• Research interests: cost-benefit analysis, economic modelling, assessing incentives and barriers to scaling up, developing decision support tools and economic methods for climate-smart agriculture

• Ph.D. in Development Economics from Wageningen University, The Netherlands
Livestock in Ethiopia

• 17% of Ethiopia GDP in 2013, dominated by cattle, mostly agro-pastoralists
  • Agro-pastoralism: settled farmers that growing crops and raise livestock with extensive grazing
  • Pastoralism is traveling with animal herds to find forage, seasonally returning home
• Livestock consume 120% of forage production in average weather years; deficits higher in drought years
• Most rangeland is degraded
Cost Benefit Analysis of Improved Livestock Management Practices in the Oromia Lowlands

• Analyzed three alternatives for improved livestock management:
  1. Deferred-rotation grazing
  2. Active restoration of degraded rangeland, and
  3. Fodder cultivation

• Selected because they enhance meat production, are important to smallholders, and improve rangeland quality
Financial and Economic Analyses and Simulation Modeling

• Financial analysis
  • Financial revenues and costs faced by firms and individuals, including taxes
  • Household scale

• Economic analysis
  • Financial analysis plus social costs and benefits, including extramarket environmental goods and services
  • Taxes and subsidies are transfer payments that do not affect GDP
  • National scale
Deferred-Rotation Grazing

• Rest grazing land by removing animals, typically for two years
• Allows natural regeneration of plants
• While lands are recovering requires alternate feed for animals
  • Often hay
  • Social and physical mechanisms for keeping animals out of areas being restored
Active Restoration of Degraded Rangeland

• Planting or seeding of desired herbaceous species
• Removal of selected woody plants
• Requires alternate area where animals can be kept during restoration and herding or fencing to keep animals out of areas being restored
Fodder Cultivation

• Planting crops with products or byproducts that have high nutritional value for livestock
• Supplemental to grazing
• Households in this analysis implemented fodder cultivation on grass covered buffer lands around crop lands
Ethiopia’s Oromia Region, Borena Zone

• Semi-arid, mean annual rainfall varies from 238-896 mm across region, and is highly variable, both spatially and temporally

• Primary livelihood is semi-nomadic pastoralist
  • Typically young men seasonally travel across region with cattle or camels
  • Fewer travel with goats and sheep

• Crop production only became common in last 30 years

• Most farmers cultivate less than 2 ha
CBA Study Area

Legend
- **Towns**
- District boundary

Data sources:
- Boundaries: gadm.org
- Towns: Geonames
Data Collection Methods

• Improved practice pilots implemented by pastoralist associations
• Survey of 86 households (32% women respondents)
  • Deferred-rotation grazing (28)
  • Active restoration (29)
  • Fodder cropping (29)
• Surveys asked about practices and production for five years before and after pilots
Analysis Methods and Assumptions

- Incremental values of improved practices per household compared to business as usual (BAU)
- Unpaid household labor valued at market wage rate
- Net present values (NPVs) at three real discount rates (after inflation)
  - 12%, 7%, and 3%
- Time horizon
  - Life of practice for financial analysis (14-21 years)
  - 50 years for economic analysis and drought sensitivity analysis
- Economic analysis included social cost of net greenhouse gas emissions
- Economic analysis of study area scaled up to national level
Financial Net Present Values (NPVs) of Business-as-Usual and Improved Practices at 12% Discount Rate

- Financial NPVs positive for BAU and improved practices, except for BAU for fodder cultivation
- Possible reasons for negative baseline NPV for fodder cultivation: lower farmer time value of money, households may attribute lower value to unpaid household labor

<table>
<thead>
<tr>
<th>Improved Practices</th>
<th>NPV of Business-as-Usual (U.S. Dollars Per Household)</th>
<th>NPV of Improved Practice (U.S. Dollars Per Household)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deferred-rotation grazing</td>
<td>$3,153</td>
<td>$1,740</td>
</tr>
<tr>
<td>Active restoration of degraded land</td>
<td>$216</td>
<td>$3,130</td>
</tr>
<tr>
<td>Fodder cultivation</td>
<td>-$64</td>
<td>$2,235</td>
</tr>
</tbody>
</table>
Incremental Financial NPVs of Changing from BAU to Improved Practices

- Switching to deferred rotation grazing reduced household NPV, largely because of cost of buying fodder while land recovers
- Incremental financial NPVs positive for switching to active restoration and fodder cultivation
- Payback periods were long, especially for deferred rotation grazing

<table>
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<tr>
<th>Improved Practices</th>
<th>Net Present Value (U.S. Dollars Per Household)</th>
<th>Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deferred-rotation grazing</td>
<td>-$1,413</td>
<td>12</td>
</tr>
<tr>
<td>Active restoration of degraded land</td>
<td>$2,914</td>
<td>6</td>
</tr>
<tr>
<td>Fodder cultivation</td>
<td>$2,299</td>
<td>4</td>
</tr>
</tbody>
</table>
Gordon Smith, Ph.D.

- Technical Lead for Sustainable Landscapes, CEADIR
- Principal, Ecofor LLC, focusing on mitigating greenhouse gas emissions by changing land use, especially forestry and agriculture quantification and offset accounting
- Ph.D. in Forestry, University of Washington; Masters in Public Policy, Harvard University
Effects of Different Discount Rate on Financial NPVs

- Incremental Financial NPVs increase as discount rates decrease
  - Upfront costs have a larger effect with high discount rates
  - Benefits begin in two to four years and continue through years 14-21

<table>
<thead>
<tr>
<th>Improved Practice (Per Household)</th>
<th>12% Discount Rate</th>
<th>7% Discount Rate</th>
<th>3% Discount Rate</th>
</tr>
</thead>
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<td>Deferred-rotation grazing</td>
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<td>Active restoration of degraded land</td>
<td>$2,914</td>
<td>$5,155</td>
<td>$8,060</td>
</tr>
<tr>
<td>Fodder cultivation</td>
<td>$2,299</td>
<td>$3,654</td>
<td>$5,561</td>
</tr>
</tbody>
</table>
Value of Greenhouse Gas Emissions and Sinks

- Deferred-rotation grazing and active restoration of rangeland increase soil carbon, removing 1.72 tCO$_2$/ha from atmosphere for 20 years.
- Fodder cropping on existing grasslands does not change soil carbon.
- Improved practices allow larger ruminant herds that increase methane emissions and offset additional carbon storage in greenhouse effects.
- Over decades, costs of increased methane from larger ruminant populations may exceed benefits of soil carbon sequestration.
Net Greenhouse Gas (GHG) Impacts Over 50 Years at a Social Cost of $8/tCO$_2$e, by Discount Rate

GHG value declines as discount rate declines because of negative value of methane emission decades after implementation

<table>
<thead>
<tr>
<th>Improved Practices</th>
<th>3% Discount Rate</th>
<th>7% Discount Rate</th>
<th>12% Discount Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deferred-rotation grazing</td>
<td>$64</td>
<td>$124</td>
<td>$113</td>
</tr>
<tr>
<td>Active restoration of degraded rangeland</td>
<td>-$350</td>
<td>-$170</td>
<td>-$95</td>
</tr>
<tr>
<td>Fodder cultivation</td>
<td>-$176</td>
<td>-$94</td>
<td>-$57</td>
</tr>
</tbody>
</table>
Net Greenhouse Gas (GHG) Impacts Over 50 Years at Three Social Costs of Carbon and a 12% Discount Rate

- Differences in net GHG costs small relative to total economic NPVs, at all three social costs of carbon
  - Relatively low carbon sequestration from grazing lands
  - Increases in methane emissions with larger herd sizes

<table>
<thead>
<tr>
<th>Improved Practices</th>
<th>$8 tCO₂e</th>
<th>$15 tCO₂e</th>
<th>$25 tCO₂e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deferred-rotation grazing</td>
<td>$113</td>
<td>$211</td>
<td>$352</td>
</tr>
<tr>
<td>Active restoration of degraded rangeland</td>
<td>-$95</td>
<td>-$177</td>
<td>-$295</td>
</tr>
<tr>
<td>Fodder cultivation</td>
<td>-$57</td>
<td>-$106</td>
<td>-$177</td>
</tr>
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</table>
Economic NPVs Over 50 Years, Including GHG Impacts at a Social Cost of Carbon of $8/tCO$_{2}$e, by Discount Rate

- Reducing discount rate increased economic NPV of all practice changes
- At 3% discount rate, deferred rotation grazing had positive incremental NPV

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<tr>
<th>Improved Practices</th>
<th>12 Percent Discount Rate</th>
<th>7 Percent Discount Rate</th>
<th>3 Percent Discount Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deferred-rotation grazing</td>
<td>-$1,404</td>
<td>-$230</td>
<td>$2,069</td>
</tr>
<tr>
<td>Active restoration of degraded rangeland</td>
<td>$2,937</td>
<td>$6,612</td>
<td>$14,767</td>
</tr>
<tr>
<td>Fodder cultivation</td>
<td>$2,121</td>
<td>$4,086</td>
<td>$8,316</td>
</tr>
</tbody>
</table>
Effects of Severe Droughts on Financial Cash Flow at 12% Discount Rate

• Data for this analysis included years with average precipitation and moderate droughts

• Effects of a severe drought every 20 years modeled in sensitivity analysis

• Severe drought assumed to reduce livestock and crop revenues 60 percent for two consecutive years, with little change in production costs
Incremental Economic NPVs Per Household Over 50 Years, With the Assumed Severe Drought Frequency, at a 12% Discount Rate

- Inclusion of severe drought risks substantially reduced economic NPVs of improved practices
- Even with positive economic NPV over 50 years, financial NPV negative in about one quarter of years, resulting in food insecurity or need to tap savings or aid

<table>
<thead>
<tr>
<th>Weather Pattern</th>
<th>Deferred-Rotation Grazing</th>
<th>Active Restoration of Degraded Rangeland</th>
<th>Fodder Cultivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix of normal rainfall and moderate droughts</td>
<td>-$1,404</td>
<td>$2,937</td>
<td>$2,193</td>
</tr>
<tr>
<td>Mix of normal rainfall, moderate droughts, and severe droughts</td>
<td>-$3,405</td>
<td>$1,152</td>
<td>$1,515</td>
</tr>
</tbody>
</table>
Incremental Economic NPVs at the National Scale Over a 50-Year Time Horizon at a 12% Discount Rate

- 14 million hectares of semi-arid and arid grazing lands in Ethiopia
- Practice changes are mutually exclusive (only one can be implemented at a particular site)
- Assumed implementation on 25% of grazing area (3.5 million ha)

<table>
<thead>
<tr>
<th>Improved Practices</th>
<th>Economic NPVs Per Hectare (U.S. Dollars)</th>
<th>Economic NPVs For 3.5 Million Hectares (Million U.S. Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deferred-rotation grazing</td>
<td>-$561.60</td>
<td>-$1,965</td>
</tr>
<tr>
<td>Active restoration of degraded rangeland</td>
<td>$5,873</td>
<td>$20,557</td>
</tr>
<tr>
<td>Fodder cultivation</td>
<td>$1,219</td>
<td>$4,266</td>
</tr>
</tbody>
</table>
Greenhouse Gas Emissions and Sinks from Scale Up

- Modest soil carbon sequestration benefits
- Net of increased methane emissions from larger herd size

<table>
<thead>
<tr>
<th>Improved Practices</th>
<th>Annual Methane Emissions Per Ha (tCO₂e)</th>
<th>Annual Social Cost of Methane Emissions For 3.5 Million Ha (million USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Social Cost of Carbon: $8/tCO₂e</td>
</tr>
<tr>
<td>Deferred-rotation grazing</td>
<td>0.872</td>
<td>-$24</td>
</tr>
<tr>
<td>Active restoration of degraded rangeland</td>
<td>4.396</td>
<td>-$123</td>
</tr>
<tr>
<td>Fodder cultivation</td>
<td>0.491</td>
<td>-$13</td>
</tr>
</tbody>
</table>
Cost-Benefit Analysis Conclusions

• Active restoration of degraded rangeland and fodder cultivation were financially and economically beneficial and higher than business-as-usual

• Deferred-rotation grazing had positive financial return, but less than business-as-usual

• All three improved practices required large up-front investments for low-income pastoralists

• Severe droughts bring many years of negative income, even with improved practices,

• Agro-pastoralists and pastoralists in Ethiopia hold livestock as store of wealth and status, rather than managing herds to maximize financial returns
  • Greater access to markets and financial services may change cultural values toward livestock and motivate agro-pastoralists to adopt more efficient production practices
Dr. Todd Crane

• Senior Scientist in the Sustainable Livestock Systems Group at ILRI
• Research examines climate change adaptation and mitigation as processes of socio-technical change
• Ph.D in Anthropology from University of Georgia, worked on USAID’s Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM-CRSP) in Mali
Social Differentiation in Climate Adaptation: One Community, Multiple Pathways In Transitioning Kenyan Pastoralism

Local Governance and Adaptation to Climate Change (LGACC)

- USAID-funded
- ILRI and ICRAF (World Agroforestry)
- 2015-2018
- Kenya and Burkina Faso
- Pastoral communities
- Kenyan Ph.D researcher: Teresiah Ng’ang’a
CCA: One Community, Multiple Pathways Research Objectives

Environmental change necessitates technical change, but this is a socially situated process

Research Objectives
“… analyze the ways that wealth, age and gender interact with climate change adaptation practices to create socially differentiated adaptation pathways”

• Group ranch → conservancy
• Rotational/bunch grazing
• Fodder cultivation

Photo: Lance Robinson
Research Design

Qualitative analysis of how adaptation practices…
• Emerge from social processes
• Affected by social institutions and norms
• Affect social distribution of benefits
Group Ranch → Conservancy

- 1995, after 1980s droughts
- Significant change in land management priorities
- Community diaspora
- Wealth-differentiated strategies
Rotational/Bunch Grazing

- Management plan by elders
- Herding by *morans*
- Friction with cultural age-set norms for young men
Fodder Cultivation

- *De facto* land enclosure
- Collective action

- Gender-differentiated impacts
  - Decrease in labor time collecting fodder
  - Increase in economic opportunity
  - Increase in household food security and nutrition

Photo: Teresiah Ng’ang’a
Conclusions about Climate Change Adaptation and Management

- Social institutions central to success, especially in pastoral systems
- Interventions need to consider social heterogeneity for social inclusion
- Interventions cannot be bracketed apart from other change dynamics

Photo: Teresiah Ng’ang’a
Closing remarks

- Effective interventions need to examine the economics and the real barriers and opportunities for implementation in specific contexts.

- There is opportunity to broaden the scope of cost and benefit analyses to consider co-benefits across livestock productivity, resilience and mitigation objectives.
FOLLOW UP

- Webinar recording and presentation will be shared with all registrants
- CBA report available at https://pdf.usaid.gov/pdf_docs/PA00X1KT.pdf
- Access previous CEADIR discussions and resources on our Climatelinks Resource Page.
- Additional questions?
  - Dr. Todd Crane: t.crane@cgiar.org
  - Dr. Polly Ericksen: p.ericksen@cgiar.org
  - Dr. Stanley Karanja Ng’ang’a: s.karanja@cgiar.org
  - Dr. Gordon Smith: gsmith@ecofor.org
  - Pablo Torres: ptorres@crownagents.com
REFERENCES

