Modeling livestock production under climate constraints in the African drylands to identify interventions for adaptation

Mottet, A., Msangi, S., Conchedda, G., Ham, F., Lesnoff, M. Fillol, E., Ickovicz, A. Cervigni, R., de Haan, C. & Gerber, P.

FAO, World Bank, IFPRI, CIRAD, Action Contre la Faim
Annual meat consumption growth rate

Source: FAOSTAT & FAO-OECD Agricultural Outlook
Density of poor livestock keepers

*Update: March 2012
Source: ILRI
Extreme drought events in the future

Consecutive dry days

Low soil moisture

Source: IPCC, Special Report on Extreme Events, 2011
Assessing livestock productivity under climate constraints

• Livestock, a “natural adapter”?  
• Early warning systems (e.g. East Africa)  
• But lack of information and data to guide interventions to move from emergency to policies building resilience  
• Limited impact assessments (IPCC WG2) and no framework integrating biophysical data and management options  
• Lack of integrative analysis of mitigation adaptation and food security
Attenuation of the effect of climate variability on herd performances

Livestock production

- Policies
  - Institutions
  - Security/health status

- Market demand/access
  - Existing services
  - Knowledge & info

Animal mobility
- Feed transport/stocks
- Feed purchased

Herd structure
- Animal health
- Breeds

Climate & biomass variability

Variation in overall feed baskets

Variation in energy intake & product output
Theoretical framework

NPP

Biogenerator

Available & accessible biomass

GLEAM

Feed rations

Animal genetics

Water availability

Animal health

Feed management & mobility decisions

GLEAM

Animal productivity
Daily weight gain & kg milk/year

MMAGE

Herd level productivity
Herd structure & herd level yields

IMPACT

Supply of animal products
Kg of meat and milk

Herd management decisions

Marketing decisions
(Off take rates, sold vs self consumed milk)

Weather & other potential crisis
Household needs
Market access

Not included
From biomass to feed

Human consumption, other usage and losses
Factor based on expert knowledge and literature

Rough biomass

Crop products & crop by-products

Crop residues

Grass

Tree cover

Usable crop & by-products

Usable crop residues

Usable grass

Usable leaves

Accessible & usable grass

Accessible & usable leaves

Feed rations

Partition based on land-use maps & FAOSTAT

Degradation, trampling, fires
Factor based on literature

Mobility, insecurity, water access, crop encroachment, boundaries...
Not estimated, assumption range 10% to 30%

CLIMATE-SMART Agriculture 2015
Animal mobility & spatial unit
Scenarios

Climatic patterns x Management interventions

- Stable Climate
- Mild drought
- Severe drought

- Health
- Early offtake of bulls

Mild drought: 10 years of mild drought, 3 years of average rainfall and 7 years of good rainfall

Severe drought, 3 years of severe drought, 7 years of mild drought, 3 years of average rainfall and 7 years of good rainfall
Feed deficit index

Annual average of the balance between usable biomass and animal requirements, using the sequence 1998-2011 as baseline (= 100) assuming full animal and feed mobility within grazing sheds.
### Absolute feed balances

Balances between biomass and animal requirements, assuming full mobility and 10% and 30% accessibility to natural vegetation

<table>
<thead>
<tr>
<th></th>
<th>Crops + by products</th>
<th>Crop residues</th>
<th>Natural vegetation (accessibility)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Past reference</td>
<td>100%</td>
<td>100%</td>
<td>95%</td>
</tr>
<tr>
<td>Baseline</td>
<td>46%</td>
<td>100%</td>
<td>106%</td>
</tr>
<tr>
<td>Drought</td>
<td>56%</td>
<td>100%</td>
<td>109%</td>
</tr>
<tr>
<td>Drought + early offtake bulls</td>
<td>39%</td>
<td>100%</td>
<td>108%</td>
</tr>
<tr>
<td>Drought + Health</td>
<td>62%</td>
<td>100%</td>
<td>111%</td>
</tr>
<tr>
<td>Drought + Health + early offtake bulls</td>
<td>39%</td>
<td>100%</td>
<td>109%</td>
</tr>
<tr>
<td>Mild Drought</td>
<td>61%</td>
<td>100%</td>
<td>109%</td>
</tr>
<tr>
<td>Mild Drought + Health intervention</td>
<td>68%</td>
<td>100%</td>
<td>111%</td>
</tr>
</tbody>
</table>
## Summary of average annual outputs for the different intervention scenarios compared to baseline

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Animal output</th>
<th>DM requirement drylands</th>
<th>Extra DM requirements humid areas</th>
<th>Red meat production drylands</th>
<th>Red meat production incl. fattened bulls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td>37 million TLU</td>
<td>428 million t</td>
<td>-</td>
<td>4.4 million tcw</td>
<td>4.4 million tcw</td>
</tr>
<tr>
<td>Drought</td>
<td>-14%</td>
<td>-26%</td>
<td>-</td>
<td>-14%</td>
<td>-14%</td>
</tr>
<tr>
<td>Drought + health</td>
<td>1%</td>
<td>-4%</td>
<td>-</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>-26%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drought + male</td>
<td>+7.7 million TLU</td>
<td>-27%</td>
<td>6.8 million t</td>
<td>-26%</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>-12%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drought + health + bulls</td>
<td>+9.3 million TLU</td>
<td>-21%</td>
<td>7.1 million t</td>
<td>-12%</td>
<td>20%</td>
</tr>
<tr>
<td>Mild drought</td>
<td>-8%</td>
<td>-4%</td>
<td>-</td>
<td>-8%</td>
<td>-8%</td>
</tr>
<tr>
<td>Mild drought + health</td>
<td>7%</td>
<td>3%</td>
<td>-</td>
<td>7%</td>
<td>7%</td>
</tr>
</tbody>
</table>
Inter-annual relative variability

Relative standard variation of usable biomass, animal intake and metabolisable energy (ME) in the baseline and the drought scenarios with different levels of interventions.
# Methods and data caveats

<table>
<thead>
<tr>
<th>Area of knowledge</th>
<th>Caveat</th>
<th>In this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock technical performance data</td>
<td>Scarce and short term, little information of climate impact on individual performances, High sensitivity of results</td>
<td>Extensive literature review and expert consultation during workshop</td>
</tr>
<tr>
<td>Natural vegetation accessibility for animal feed</td>
<td>Inexistent, Nor is info on water points</td>
<td>Range of 10% to 30% accessibility assumed</td>
</tr>
<tr>
<td>Animal mobility</td>
<td>Partial knowledge, lack of regional assessments</td>
<td>Definition of the ‘grazing shed’, as a spatial unit self-contained in terms of animal mobility</td>
</tr>
<tr>
<td>Characterization of feed resources and their quality</td>
<td>Scarce information</td>
<td>Literature review and expert consultation during workshop</td>
</tr>
<tr>
<td>Livestock numbers official statistics</td>
<td>Inaccurate for pastoral systems</td>
<td>Relied on FAOSTAT data</td>
</tr>
</tbody>
</table>
Discussion & conclusion

• Baseline: 2.5 times more available resources, but not necessarily accessible. In some scenarios, this may go up to 3.5 times
• But potential for sector’s growth is feed resources made accessible
• Calls for interventions in animal mobility (corridors, security, border regulations, health, tenure), feed management (storage, processing, transport) and stratification to reduce pressure in arid areas
• Rangelands: accessibility very low in some areas (Chad), not so low in other (Ferlo). Open new areas to livestock, without degrading the environment?
• Potential yes but with much less people (livelihood threshold analysis)
• Animal health interventions: to be coupled with interventions to increase access to feed. Otherwise full benefits not achieved + conflicts over resources increase
• Bulls early offtake: clear potential but practical obstacles (market access, infrastructure) & human factor (reluctance to sell, even if offered a higher price). On the ground experience and good practices (Morocco)?