Livestock modelling as part of farming systems assessments in regional integrated assessments

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Land use
Natural resource use and degradation
Greenhouse gas emissions
Increasing demand for livestock products
Climate change effects on livestock systems

- Biomass production (grain + stover)
- Crop suitability
- Cropping patterns

- Feed intake
- Animal growth and health
- Milk production
- Fertility

- Water resources

- Pests
- Weeds
- Diseases

- Biomass production
- Species composition
- Herbage quality
Effects of climate change also on system shifts
- Livestock may become more important with shortening of growing season
- (Seasonal) migration may become more important

Fig. 3 – Transition zones in the mixed rainfed arid–semi-arid system, in which the Reliable Crop Growing Days (RCGD) falls below 90 between 2000 and 2050, as projected using the HadCM32 model and the A1FI scenario.
Effects of climate change also on system shifts

- Livestock may become more important with shortening of growing season
- (Seasonal) migration may become more important
- Extreme events: droughts wiping out entire herds

Toulmin 1994
IPCC WG2 SPM coverage of crop vs livestock

Howden, 2014
IPCC WG2 ‘Food Security’ chapter coverage

Howden, 2014
IPCC WG2 ‘Regional’ chapter coverage
Climate data

- Historical (1980-2010):
- Mid century (2040-2070):
  - 20 GCMs
  - Projected changes in temperature, precipitation

Crop Model

APSIM, DSSAT

Crop management:
- fertilizer, rotation, varieties,…

Effects on on-farm crop production

Livestock model

LivSim

On-farm feed production;
- rangeland biomass

Effects on livestock production (milk, off-take, mortality rates)

Economic model

TOA-MD

- Household characteristics
- Agricultural production
- Prices, costs

Economic effects of climate change and adaptations on entire farms

All households (n=160)

Economic impacts
- Heterogeneous populations
- Types of households

Modelling framework
Climate data

Crop Model
  APSIM /DSSAT

Livestock model
  LivSim
  Effects on livestock production (milk, off-take, mortality rates)

Grazing land model
  Effects on grazing land biomass availability

Household information
  Herd size and composition
  Crops and field sizes

Livestock management information

Economic model
  TOA-MD
  Economic effects of climate change and adaptations on entire farms
Climate data

Crop Model
- APSIM /DSSAT

Livestock model
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Economic model
- TOA-MD
  Economic effects of climate change and adaptations on entire farms

Things to note
1. Dashed arrow from climate to livestock

12
Climate data
- APSIM/DSSAT

Crop Model
- Livestock model: LivSim
  - Effects on livestock production (milk, off-take, mortality rates)

Livestock model

Grazing land model
- Effects on grazing land biomass availability

Household information
- Herd size and composition
- Crops and field sizes

Livestock management information

Economic model
- TOA-MD
  - Economic effects of climate change and adaptations on entire farms

Things to note
2. Estimating grazing intake:
- Grazing land area, stocking density, rangeland/pasture productivity
- Rangeland model
- Grass production in APSIM/DSSAT
- Rainfall use efficiency
- Average availability
Climate data

Crop Model
APSIM /DSSAT

Livestock model
LivSim
Effects on livestock production (milk, off-take, mortality rates)

Grazing land model
Effects on grazing land biomass availability

Livestock model
LivSim
Effects on livestock production (milk, off-take, mortality rates)

Household information
Herd size and composition
Crops and field sizes
Livestock management information

Economic model
TOA-MD
Economic effects of climate change and adaptations on entire farms

Things to note
3. Crop model outputs
- Crop residues
- Forages

Household info on field sizes
Climate data

Crop Model
APSIM / DSSAT

Livestock model
LivSim
Effects on livestock production (milk, off-take, mortality rates)

Grazing land model
Effects on grazing land biomass availability

Household information
Herd size and composition
Crops and field sizes
Livestock management information

Economic model
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Things to note
4. Household information
- Crops and field sizes
- Initial herd size and composition
- Livestock management
LivSim structure and functioning

- Based on production ecology principles
- Monthly time step
- Individual animals in a herd are modelled
- Greenhouse gas emissions added as output
## Table: Household Information

<table>
<thead>
<tr>
<th>Household ID</th>
<th>Cattle holding</th>
<th>Total cropland (ha)</th>
<th>Maize area (ha)</th>
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## Graph: Maize Stover Yield

- **Title:** Maize Stover Yield (kg DM/ha)
- **Legend:**
  - Green: Current Climate 1
  - Red: Current Climate 2

The graph shows the variation in maize stover yield over time, with two climate scenarios represented. The data points indicate fluctuations in yield, reflecting the impact of climate on agricultural productivity.
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Pasture energy availability (MJ ME/animal/day)

Example

Farm-level fodder availability

On Farm fodder production (kg DM/animal/year)

Community-managed grazing land

Dry season feeding of maize crop residues
Example

One cow

Graphs showing:
- Monthly milk production (kg)
- Body weight (kg)
Scenarios
1. Current climate
2. Future climate
3. Future climate with “incremental improvement package”
• Livestock model comparison, sensitivity analysis
• Direct T effect not yet included
• Uncertainty in feed availability estimates for extensive systems
• Data availability for model calibration, model setup and input data
• Weak modelling capabilities in the region
THANK YOU