

### Implementing ecological functions in a land use change model to assess impacts of crop expansion and overstocking in a Kenyan savanna

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#### Introduction

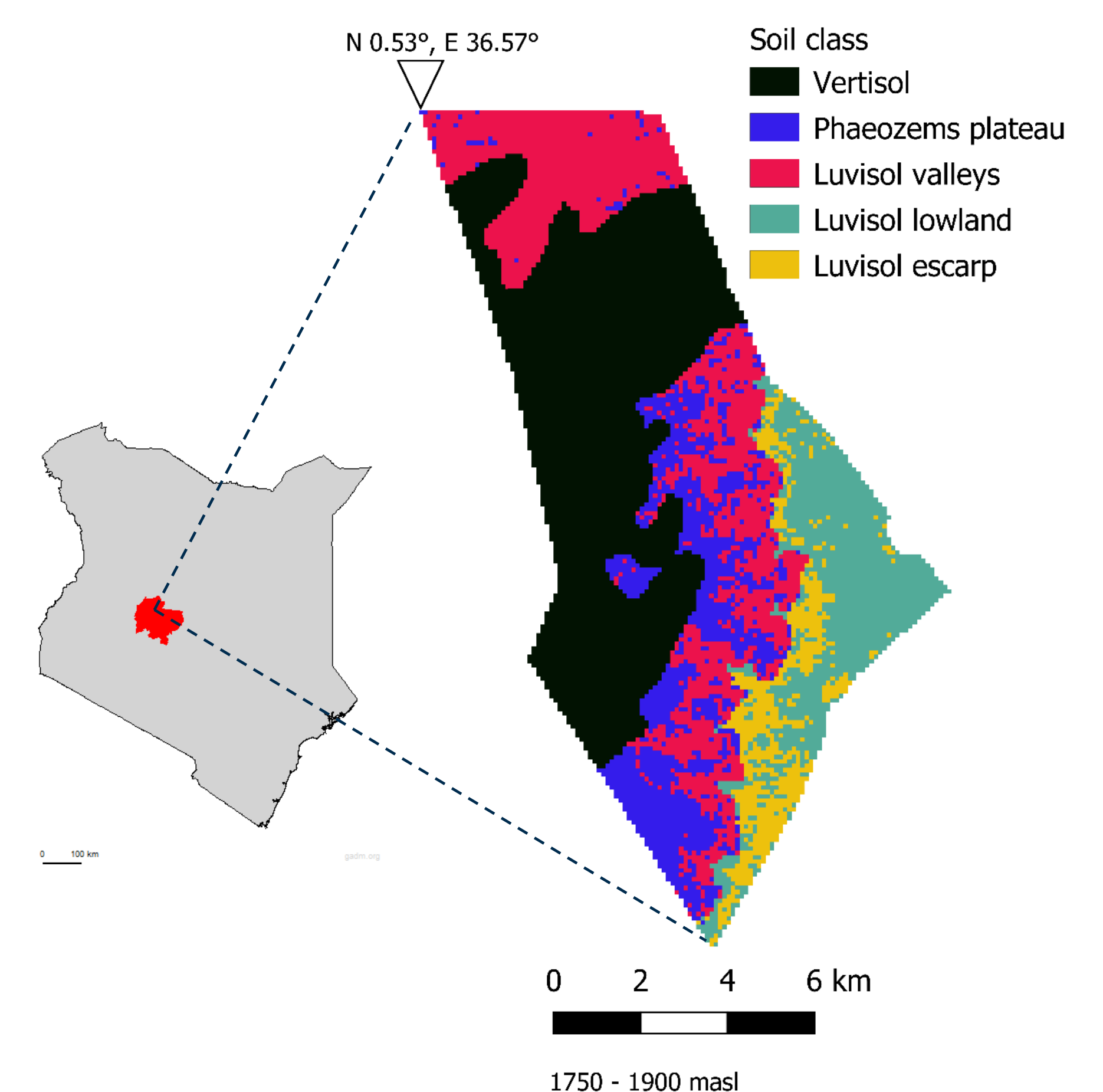
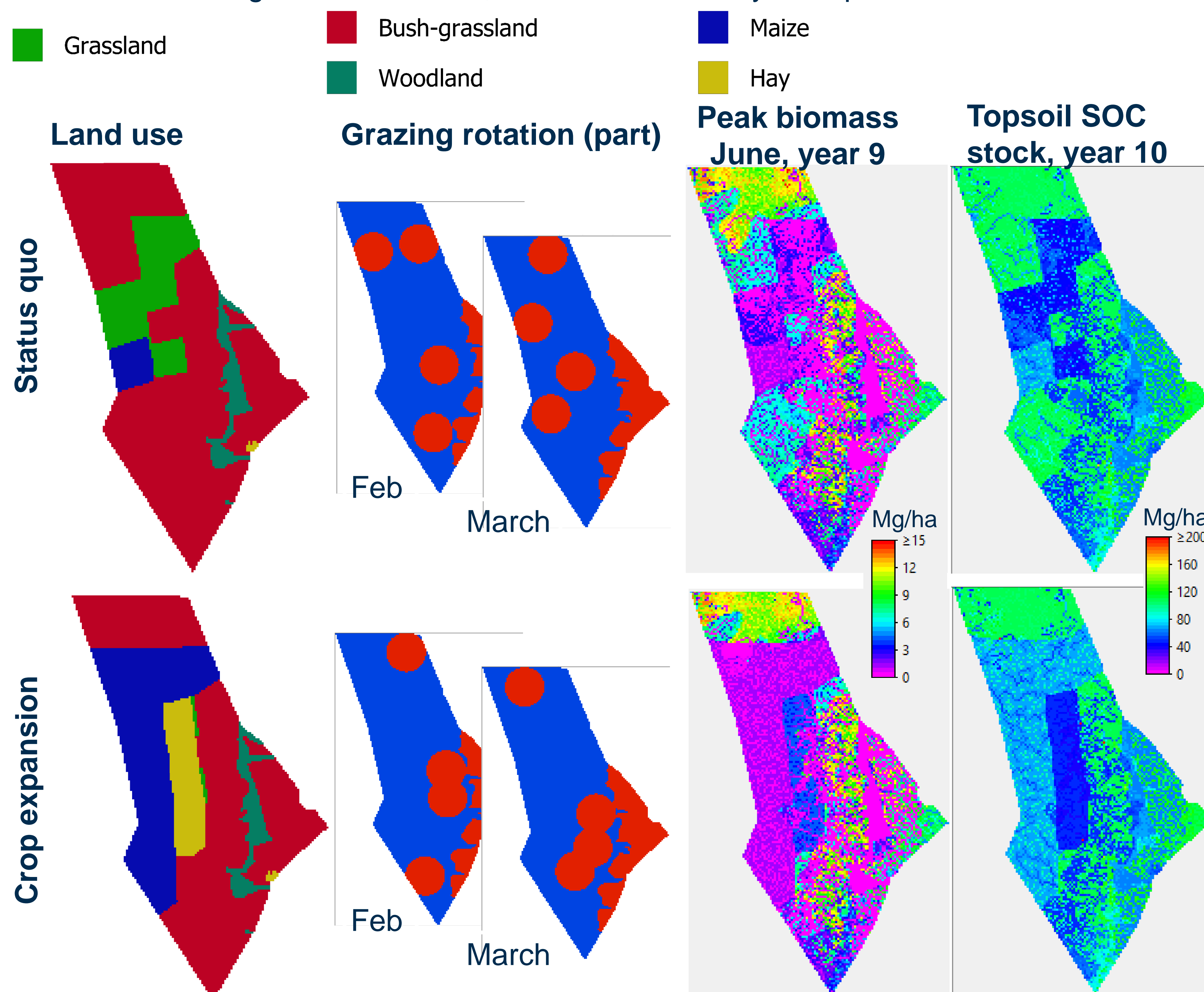
- Veg. cover is seasonally reduced under cropping and tillage disturbs soil
  - Loss of rangeland to cropping increases grazing pressure on remaining pastures, causing rangeland degradation
  - Does **large-scale conversion** of African savannas to cropland generate negative ecological impacts?
  - Land conversion is happening on Ol Maisor ranch and a lot more is planned
  - Large scale land use change (LUC) impacts cannot be tested in the field
- We amend and employ the process-based model LUCIA to run scenarios

#### Model scenarios: Crop expansion vs. Status quo

- 10 year model runs, 4 corrals with 600 cattle each, monthly shifting corral locations, crop and hay expansion reduces pasture from 10,500 to 6,100 ha
- Higher grazing frequency of remaining pastures in crop expansion scenario does not cause additional pasture degradation
- SOC is higher under maize, but lower under hay after pasture conversion

#### Discussion and Conclusion

- Pasture is more productive and grazing resistant on less clayey red soils due to higher plant water availability, despite tree competition
- Plant growth is patchy, because it is highly influenced by lateral water flows
- SOC increases after grassland conversion to maize, because residues are left on fields and are not removed for livestock feeding
- Adjustment of soil physical equations improved simulation of clay soil hydrology and enhanced pasture (re)growth
- Pasture degradation was observed where water limitation and overgrazing coincided



Study site: 11,500 ha farmland in Laikipia  
 640 mm avg. annual rain in 2 rainy seasons  
 Black cotton soil (Vertisol) & Red loam soils

#### Model validation

Topsoil moisture predicted well over 7 weeks for different soils and land uses:  $R^2$  0.52 – 0.75

Year 2018	observed	predicted
Peak grass AGB Mg/ha	2	3
Maize AGB Mg/ha	19	11
Hay cut Mg/ha	8	6

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#### Materials and Methods

Added **grazing** and **growth reserves** to LUCIA

##### Growth reserves module

- Enables regrowth after grazing
- Reserve depletion causes plant death and vegetation degradation

##### LUCIA model

- Land Use Change Impact Assessment tool ([lucia.uni-hohenheim.de](http://lucia.uni-hohenheim.de))
- Spatially explicit, process-based
- Daily timestep, 100m grid resolution

##### Grazing module

- Monthly shifting grazing locations
- Constant herd size and herbage offtake
- Dung and urine NPK contents depend on plant NPK contents