Whole farm greenhouse gas emissions and trade-offs across smallholder livestock systems

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Background

- Livestock systems in East Africa (EA) have one of the highest greenhouse gas (GHG) emissions intensities and lowest feed use efficiencies worldwide
- GHG mitigation in EA is only viable if synergetic with livelihood improvement of smallholders
- Therefore, multi-dimensional analysis is necessary to explore climate-smart options that reduce trade-offs between GHG mitigation and household income

Figure 1. Livestock feeding on maize residues, communal grassland and fresh natural vegetation

Materials and Methods

- Study site was Babati, Northern Tanzania, which represents a high diversity of agro-ecological zones and farming systems
- Livestock and feed based typology was derived from household survey using principal component and hierarchical cluster analysis
- Bio-economic multi-objective optimization model FarmDESIGN was extended with a GHG quantification module (IPCC Tier 1 and 2)
- All identified livestock systems were simulated with the model, and optimized for decreased GHG emissions, increased profits and increased nitrogen balances
- Climate-smart intensification options were discussed with farmers during in-depth follow up interviews

Results

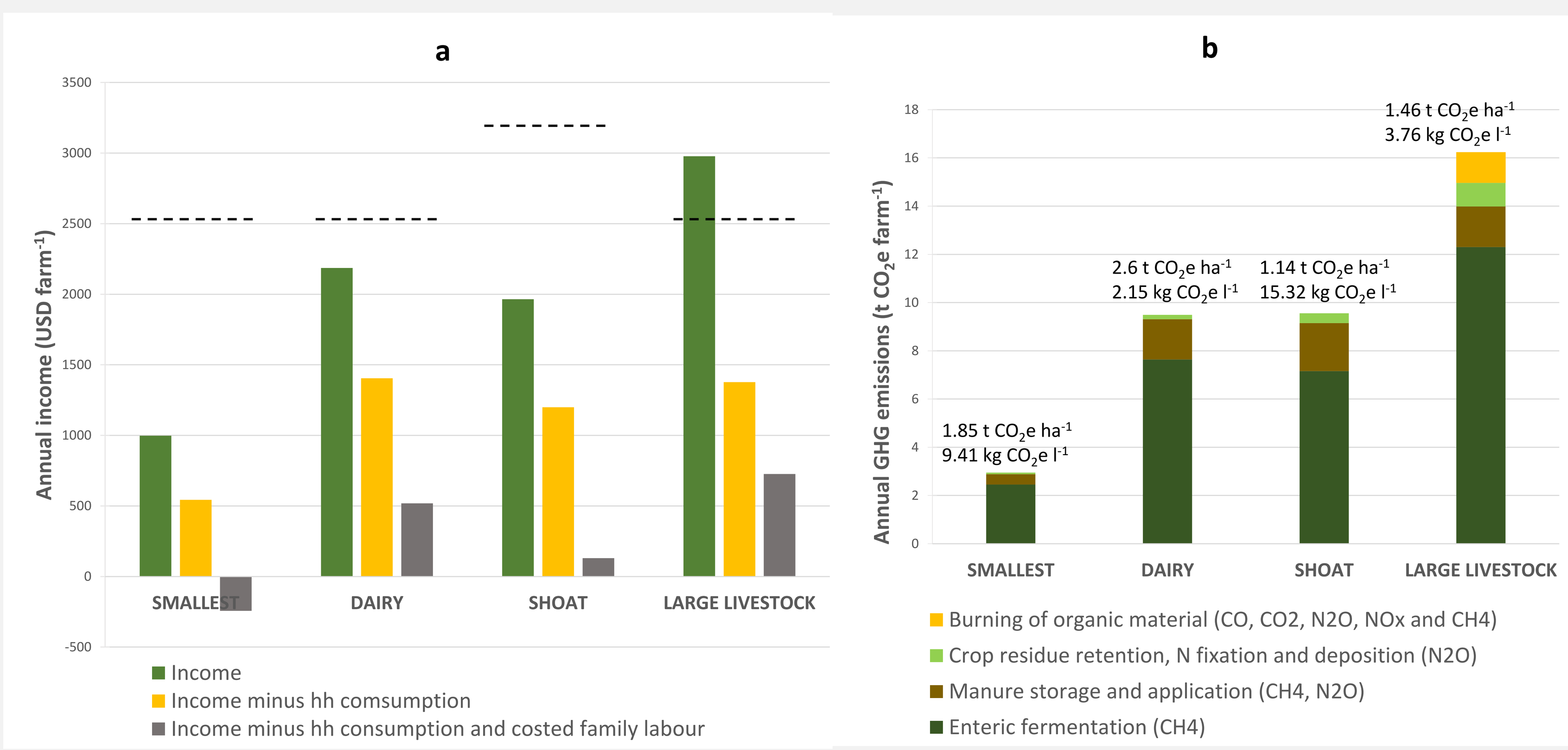

Figure 2. Annual income (a) and GHG emissions (b) per livestock system. The dashed line illustrates the poverty line at 1 US per household member per day (a). Numbers above bars denote emission intensities per land and unit milk produced (b).

- More than 90% of whole-farm emissions came from livestock (enteric fermentation and manure)
- Emissions (2.9 to 16.2 t CO_2e) were higher than in other smallholder systems in East Africa due to extensive livestock
- Emission intensity per kg milk was lowest for the DAIRY type

Results

- All livestock systems had alternatives available to increase income while decreasing GHG emissions, thereby reducing agro-environmental trade-offs
- These climate-smart options included reducing ruminant numbers, replacing local cattle with improved dairy breeds, improving feeding through on-farm Napier grass (*Pennisetum purpureum)* cultivation, and reducing crop residue feeding to leave them on the field

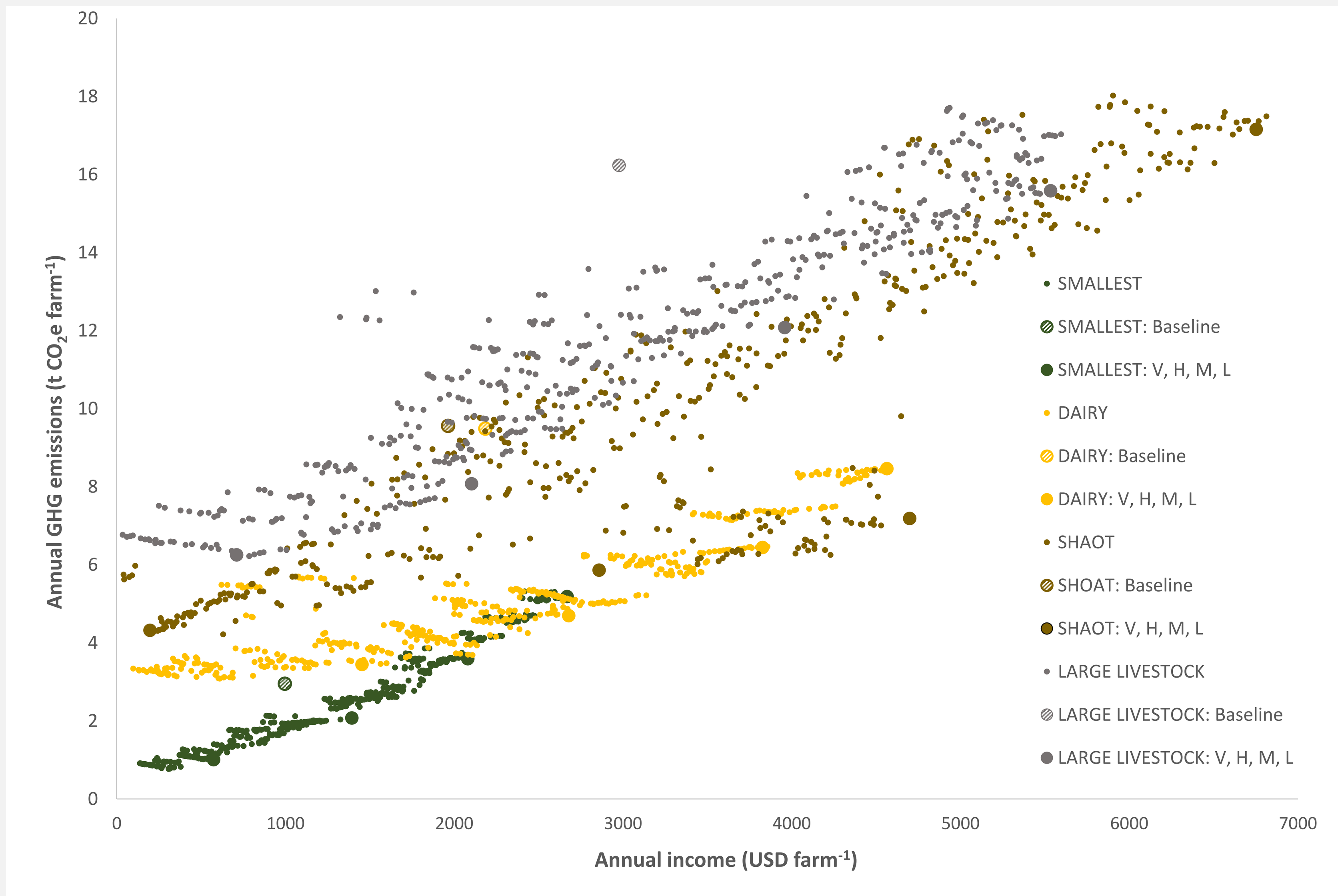

Figure 3. Trade-offs between annual income and GHG emissions across livestock systems. The large dots with pattern denote the baseline position, whereas all other 377 dots are model-generated farm constellations. V=very high income and GHG, H=high, M=medium, L=low

- Main obstacles to adoption of these climate-smart technologies included high skill level required to re-organize entire production system, loss of some multi-functionality of livestock, and higher production risks

Conclusions

- Livestock is a viable starting point for GHG mitigation in EA
- However, low baseline emissions underline that mitigation should be co-benefit, not main objective
- Improving livestock breeds and feeding are climate-smart options that decrease trade-offs between GHG mitigation and income
- Obstacles to adoption are associated with lack of capacities and increased risks

- Integrated bio-economic modeling is useful to target climate-smart technologies and quantify trade-offs
- Climate-smart livestock intensification options should be a building block of Tanzania's climate policies if synergetic with livelihood improvements – such as improved livestock breeds and feeding

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