Valuation of livestock eco-agri-food systems: poultry, beef and dairy

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Acknowledgement

Study has been executed in a cooperation between:

- Trucost
- True Price
- WUR : Livestock Research
- WUR : LEI
- WUR : Alterra

Background and goal of study

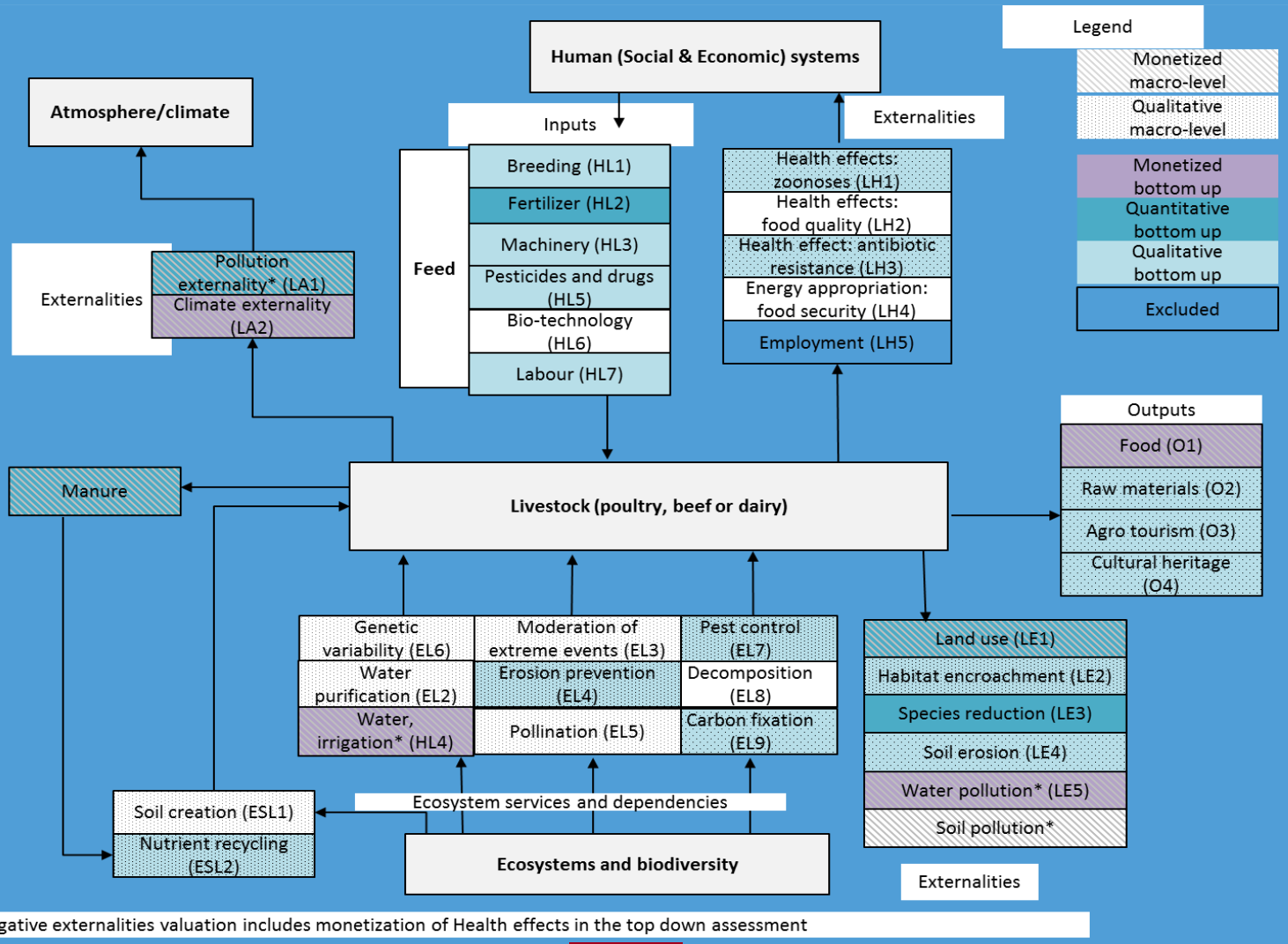
Background

- Livestock production uses natural capital and generates positive and negative externalities on humans, ecosystems and biodiversity.

Main research question

- To assess the visible and invisible values of biodiversity and ecosystems to the various types of agriculture systems (inputs) and evaluate the scale, range and degree of both positive and negative impacts of livestock production systems on ecosystems, health and livelihoods (outputs);

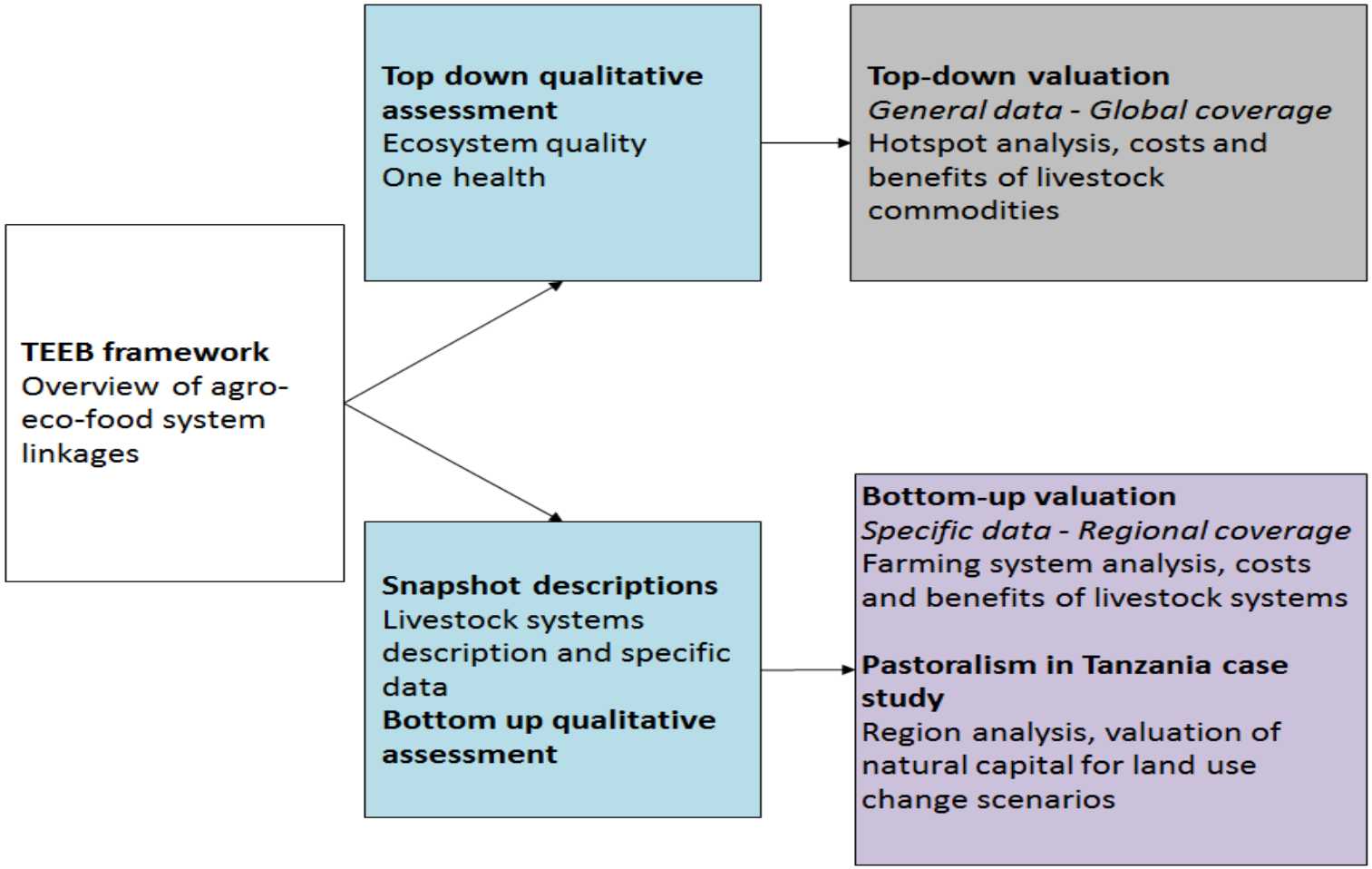
Scope of the assessment



Scope of the assessment

	Qualitative	Quantitative	Monetized
Top down	Drugs Health effects Outputs other than protein Habitat encroachment Nutrient recycling Soil erosion		Air pollution Water pollution GHG emissions Water abstraction Land occupation Soil pollutants Protein production Manure production
Bottom up	Drugs Health effects Outputs other than protein Habitat encroachment Nutrient recycling Soil erosion Use of manufactured inputs Breeding	Land occupation Species reduction Fertilizer use Nutrient surplus	Protein production Water dependency Water pollution GHG emissions
Tanzania case study			Carbon stocks Raw materials Crops Livestock products Wild food Drinking water Forest products

Overview of methodologies used



Top-down approach

- Qualitatively reviews the benefits provided by livestock through a literature review. It also values a selection of benefits derived from livestock: food and manure provisioning.
- For all poultry, beef and milk producing countries (over 190 countries), it values the natural capital costs from:
    1. GHG emissions
    2. Air pollutants
    3. Water consumption
    4. Water pollutants
    5. Soil pollutants
    6. Land use change
- Through a literature review, it qualitatively assesses:
    - the interaction of livestock systems and biodiversity
    - the interaction between animal health and human health

Top-down Valuation

- System boundaries for most aspects: Livestock farming and production of inputs (upstream supply chain).
- Quantification: Trucost's Environmentally Extended Input-Output model
- Valuation: integrated biophysical and economic model, which follows the methodology proposed by Keeler et al. (2012). Value transfer is used (Brander et al. 2013).
- The quantification and valuation of farming operations is country specific when possible; otherwise is global. The quantification and valuation of the upstream supply chain uses global average factors.
- Valuation coefficients are used for each natural capital impact. For example, EPA Social Cost of Carbon (128 $ per tonne) is used to value the impact from GHG emissions.

Bottom-up approach

- Snapshot description of ten livestock production systems in five countries on all issues.
- System boundaries: livestock farming and production of feed.
- Valuation per snapshot of :
  - GHG emissions
  - Water pollutions
  - Blue water dependency
- Quantification of land occupation
- Land-use impacts on biodiversity
- In depth case study of Pastoralism in the Maasai Steppe in Tanzania
- Main data sources: FAOSTAT and GLEAM

In depth case study of Pastoralism in the Maasai Steppe in Tanzania

- Value of pastoralism for landscape conservation
- Proposes new framework for quantifying internal value of natural capital assets in a region with a dynamic model
- Comparison of land conversion scenarios and impacts on natural capital value
- Quantification of livestock, crops, tourism, wood, wild foods, and other final ecosystem services
- Carbon stocks
- Key limitation: data intensive approach, limit to the amount of scenarios that could be investigated

Key finding Top-down approach (1)

- Natural capital costs

Indicator	Beef	Milk	Poultry meat
Total natural capital costs (trillion US$)	1.5	0.5	0.3
Contribution of farming operations (%)	78%	65%	29%
Cost share for the top 5 countries Cost share for the EU-28 (not in top 5)	50% 8%	39% 19%	43% 11%

- Natural capital intensities (in $ per kg protein)
  - On average for all producing countries: Beef>milk>poultry meat. The main reason for this order is high the GHG emissions and land use change for beef production compared to milk and poultry production.
  - EU countries have a lower natural capital intensity than the global average due to higher efficiencies for livestock production.

Key finding Top-down approach (2)

Natural capital aspect	Beef	Milk	Poultry
GHG emissions	18%	23%	39%
Land use	73%	68%	35%
Air pollutants	8%	8%	24%
water consumption, water pollutants and soil pollutants	< 2%	< 2%	< 2%

Key finding Top-down approach (3)

- Benefits: diverse cultural (i.e. tourism), regulating (i.e. soil carbon sequestration), supporting (i.e. connexion of habitats) and provisioning services (i.e. provision of food, which is a key benefit).
- Biodiversity impact: Livestock production impacts biodiversity in different ways. Depending on local conditions impact differ in type and magnitude.
- Animal and human health: huge direct and indirect impact; positive and negative externalities are possible. Elements are food, zoonoses, use of antibiotics. Diseases from poultry have bigger impact on human health than diseases from cattle.

Key findings bottom-up analysis (1)

	Beef	Milk	Poultry
Carbon externality as % of average retail price	157%	57%	26%
Natural capital costs of GHG in USD per kg of protein	35-40	5-18	4-5
Land occupation m2 per kg of protein	1131-10913	23-1231	0-58

Key findings bottom-up analysis (2)

- Snapshot specific findings
  - Natural capital costs of dairy farms in NL with milk and meat and poultry meat in NL are of same order.

    but

    a. meat quality of milk dairy cows and their offspring is different from pure beef production;

    b. nutrient load per ha is high in dairy due to high stocking density.
  - Improvements within livestock production system can decrease natural capital costs up to 20%.
  - In backyard systems the environmental profile of feed is low, while feed conversion rate is poor, in intensive systems environmental profile of feed is high, but feed conversion rate is very good.
  - Pastoralist systems have a low natural capital efficiency however this system does not affect biodiversity and natural capital negatively (see the in depth study of Maasai Steppe in Tanzania)

Key findings bottom-up analysis (3)

- Biodiversity
  - Livestock impacts biodiversity directly and indirectly. The impact on biodiversity per ha of production system is smallest for the pastoralist systems and is higher for the more intensive and feed based production systems.
  - For poultry the relation is more obscure. Systems are called “land-less” but in reality poultry production and feed production are spatially disconnected.
  - In extensive conditions, sustainable intensification is a solution to reduce the environmental impact per unit of product. Further intensification of intensive systems has little effect.
- Animal and human health
  - large variation in use of antibiotics within and between species.
  - Zoonoses exists in all regions and livestock production systems.
  - Impact of food born diseases is more or less unknown, but can play an important role.

Key findings bottom-up analysis (4)

- In depth study Maasai Steppe
  - Internal value of natural capital 2.7 – 4.6 Billion USD.
  - Low speed of land conversion increases internal natural capital value of the Maasai Steppe
  - Carbon emissions are also important negative externality of conversion to arable cropping.
  - Livestock production contributes to ecosystem quality and provide food. Some farming systems are a threat to the ecosystem quality. Tourism is stimulated by way Maasai manage their land.

Conclusions (1)

- Overall: Livestock sector present many risks for natural capital but much can be done to face these risks. Future needs of proteins can be fulfilled without increasing natural capital costs.
- Livestock production results in an ecological footprint.
- Production of animal protein is expected to grow.
- Implications of systems with high productivity levels and high levels of inputs like feed, capital and medicines are clear and have relative low natural capital costs. These systems have potential to feed urban regions all over the world.
- Natural capital costs increase from poultry, milk to beef in average terms. However within every species there may be room to decrease natural capital costs per kg of protein. For ruminants there are double wins especially for smallholders in Asia and Africa.
- Subsistence systems have low inputs and outputs per kg of protein. These systems supply food to the most vulnerable populations, are well adapted to local constraints and have a low or even positive impact on biodiversity.

Conclusions (2)

- Sustainable intensification pathways are possible for each species but these pathways depend on the local context.
- Methodology: top-down and bottom-up are complementary approaches that allow:
    - Determining the impact of livestock sectors worldwide and identifying hotspots;
    - Gaining deeper insight in particular locations with specific types of production systems.
- Part of the impacts are hard to quantify, but important factors to consider: one health, biodiversity, edibility of products.

Agenda for future research

- To an integral assessment

Present study is still partial, with limited snapshots and themes valued. Besides costs also benefits need to be valued.

- The next right questions

Look at substitutability of production systems; combined arable-livestock systems; attention to smallholders

- Agriculture for landscape management and the value of ecosystems

Livestock systems produce food but also manage landscape. For other regions than the Maasai Steppe in Tanzania insight in the relation of agriculture systems with semi-natural ecosystem can support sustainability.

Thanks for the attention

Methods and data : TEEB Framework: overview of agro-eco- food system